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Electric haulage at the Moctezuma copper property

May 25, 1931

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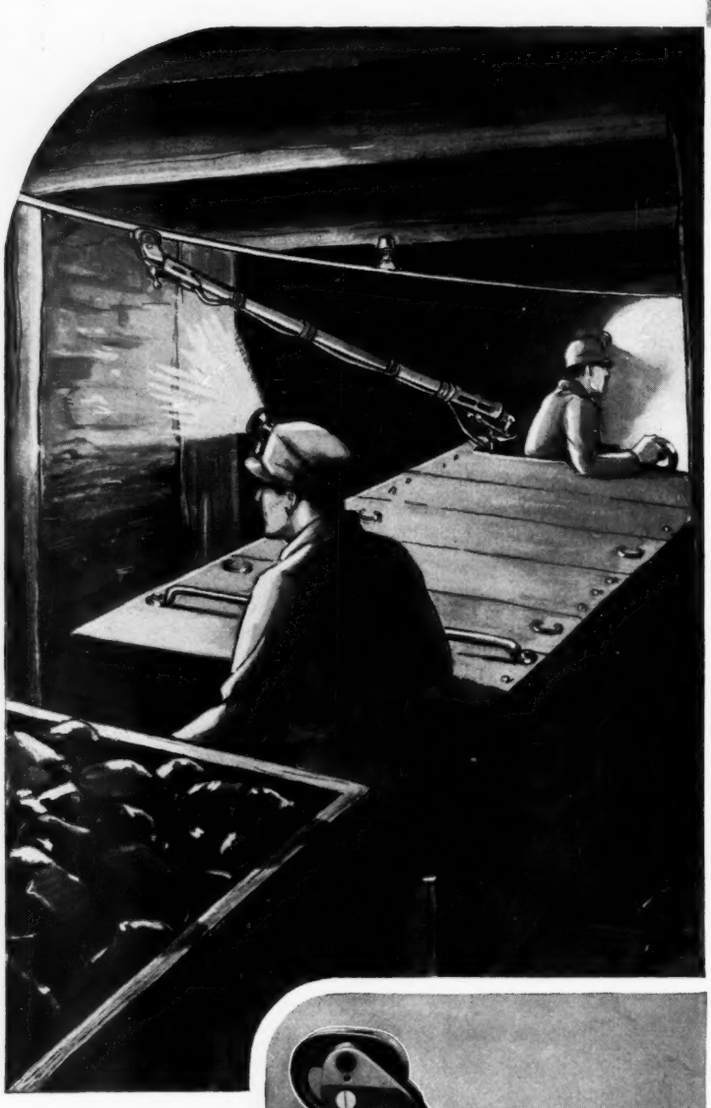

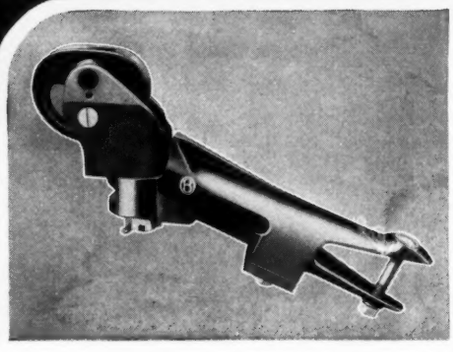

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VOLUME 131 . . . NUMBER 10

Editorials 445

The Institute Stages a Celebration . . . Utilizing Diesel-Engine Waste Heat . . . Free-Wheeling and Asbestos Market Conditions . . . The Prospector Is Worthy of His Hire . . . Another Mineral Byproduct Plant Reaches Production . . . Deep Gold Mines and Geothermal Gradients . . . Providing Adequate Insurance Against Survival

Safety Cage-Signaling System.....*L. D. Stewart* 448

Leaching Oxidized Copper Ore.....*W. J. Loring* 450

Natural Gas.....*A. H. Hubbell* 453

Weir Discharge Chart.....*Sydney C. Mifflen* 459

Vanadium Recovery.....*Bjorn P. F. Kjellberg* 460

Crushing and Flotation at Morenci.....*George J. Young* 461

Amalgamation Practice in Canada.....*Ronald A. Vary* 463

Impurities in High-Grade Zinc.....*B. H. Strom* 465

Origin of Chilean Nitrate.....*Bjarne Hofseth* 467

Book Reviews 470
Comment, Criticism, Personals 472
Industrial Progress 474
News of the Industry 477
Market and Financial News.....485
Professional Directory 38
Searchlight Section 39
Advertising Index 42

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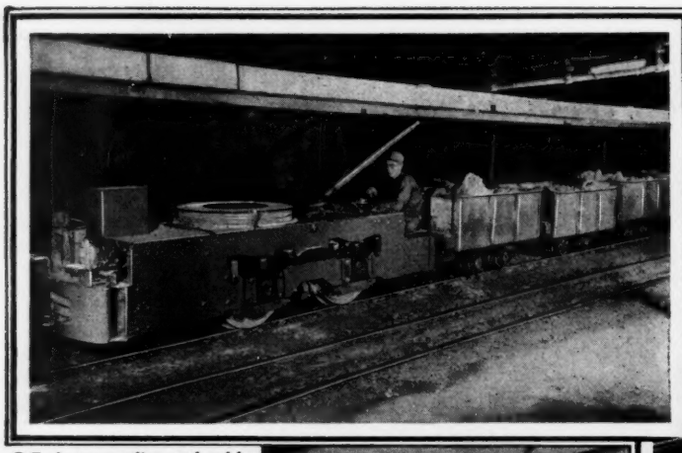
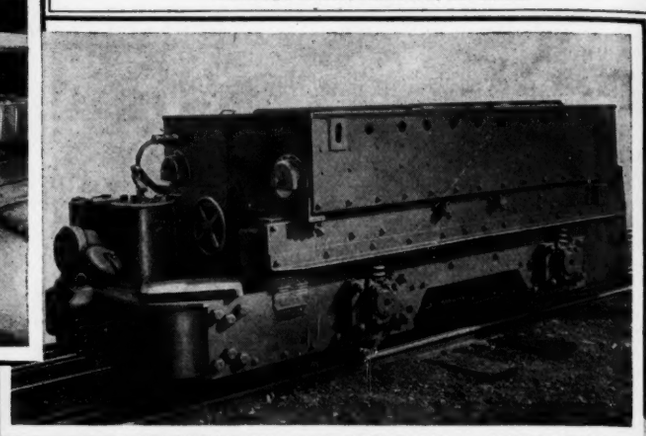


G-E six-ton battery-type locomotive at Roan Antelope Mines, Rhodesia, So. Africa



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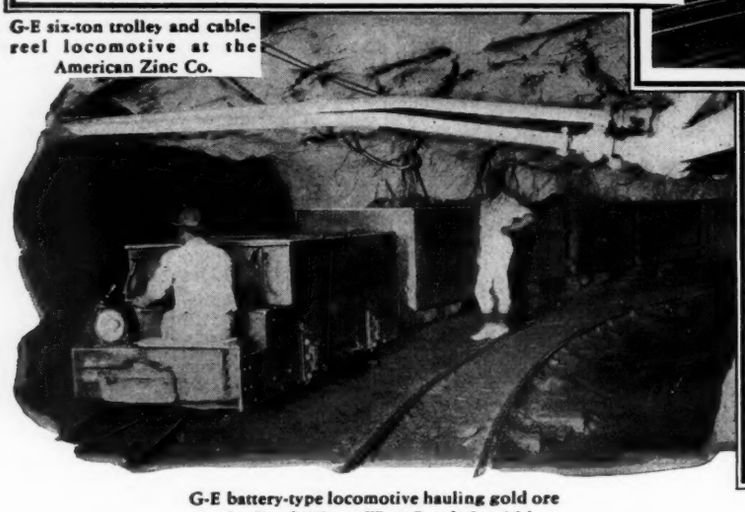
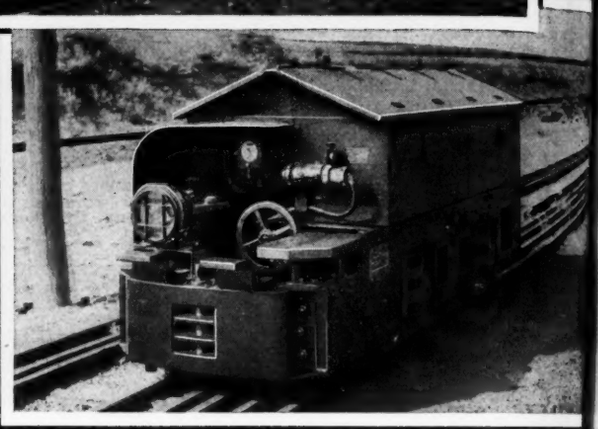


G-E battery-type locomotive hauling gold ore in the Rand Mines, West Rand, So. Africa



G-E four-ton battery-type locomotive at Federal Mining & Smelting Co.

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GENERAL

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Engineering and Mining Journal

May 25, 1931 A. W. ALLEN, *Editor* Vol. 131—No. 10

The Institute Stages a Celebration

IN A DEPARTMENT of this publication entitled "Sixty Years Ago," attention was once drawn to the fact that an editorial in *Engineering and Mining Journal* of Feb. 7, 1871, contained the first announcement to the profession and industry of mining engineering of a proposal that had long been favored by its editor, Dr. Rossiter W. Raymond—the forming of a professional society to be known as the American Institute of Mining Engineers, in the fostering and direction of which he subsequently played so zealous and honorable a rôle. Doctor Raymond, as befitted one with the best interests of the industry at heart, was tireless in urging the free interchange of experiences, among those engaged in technical work. "It is therefore proposed," he announced, "to establish an American Institute of Mining Engineers which will hold its meeting periodically in the great mining and metallurgical centers." The printing and distribution of the papers presented and the discussion contributed at such meetings would be an obligation of the new Institute. These "transactions" or "proceedings," Doctor Raymond averred, "would form, when published, a valuable and greatly needed addition to our technical literature."

The initial circular calling a meeting to organize the new society was signed by three engineers, one of whom was R. P. Rothwell, who later became joint editor with Doctor Raymond of *Engineering and Mining Journal*. Thus the early history of the Institute was directly linked with that of the industry's mouthpiece. Of the four who organized the Institute—E. B. Coxe, R. P. Rothwell, M. Coryell, and R. W. Raymond—two directed the editorial performance and policies of this publication. *Engineering and Mining Journal* gave the necessary impetus to the scheme and provided space for accounts of meetings and progress. Doctor Raymond, its editor, was virtually the president of the Institute from the time of its foundation, although David Thomas filled that post by name if not by performance for a few months before Doctor Raymond became titular head, to hold the office until he himself introduced an amendment to the constitution that limited presidential service to two years only. In 1884 he became secretary of the Institute, the duties of which he performed with keen perception, rare charm, and conspicuous literary ability. His retirement in 1912 was followed by close association with the Institute, as Secretary Emeritus, until his death in 1918. And during this period he was a valued contributor to *Engineering and Mining Journal*.

In its issue of May 30, 1871, *Engineering and Mining Journal* presented a complete report of the first meeting of the Institute, which was held at Wilkes-Barre, Pa., on May 16, 17, and 18, and it is fitting that the Pennsylvania Section of the A.I.M.E. should have recognized this fact at the meeting held there last week. *Engineering and Mining Journal* takes pride in the part its editors played in the foundation of a national engineering society six decades ago. It joins in paying tribute to the pioneers, especially to the memory of Rossiter Raymond, who steered the Institute, through many years of dignified and honorable activity, to a success that was notable in journalistic quality and technical prestige.

Utilizing Diesel-Engine Waste Heat

WITH mining and metallurgical operations rapidly approaching the limits of technical and economic efficiency, the cost of power is being subjected to close scrutiny. Attention is being paid to the fact that lower generating costs can be secured by the maximum possible introduction of automatic control, coupled with the utilization of heat in the cooling water and exhaust gases of oil or gas engines, if these are employed as prime movers. The importance of this subject has not been sufficiently recognized by those in control of many Diesel power plants.

Well-designed recuperators—by which, incidentally, the thermal efficiency of a Diesel engine is raised—may effect considerable plant economies. Heavy expense is usually involved for the maintenance of boilers to supply heat and warm water to change rooms and offices. This can be avoided by passing the engine cooling water, preheated to about 185 deg. F. in a waste-heat boiler attached to the exhaust pipe of the Diesel engine, to the central heating system containing a circulating water cooler. Oil- or coal-fired dryers at the filter plant can be replaced by simple drying chambers that utilize waste-heat air heaters. Distilled water, another costly item, used at the laboratory, for the maintenance of electric batteries, and for other requirements at mine and mill, can be produced economically in a small plant heated by the exhaust gases of the engine. Where large Diesel units are available, low-pressure steam up to seven pounds per square inch, produced in special waste-heat boilers, can be used for heating, drying, boiling and steaming; and high-pressure steam up to ninety pounds per square inch, for power generation.

The opportunities outlined in the foregoing are worth investigating. The practicability of effecting economies by the utilization of waste heat from Diesel power units has been demonstrated successfully in the United States, Europe, Chile, and Cuba. Innovations of this character, involving but a slight increase in plant investment, offer mining companies possibilities of cutting operating costs in several departments.

Free-Wheeling and Asbestos Market Conditions

A SURVEY of the markets for manufactured asbestos products seems to reveal improvement, even though slight when seasonal factors are discounted, compared with conditions that prevailed last year. One of the principal expanding outlets is apparently in the automobile industry, where a more extensive use of asbestos in several of its manufactured forms is evident. For instance, in the brake-lining industry, larger sales are expected. The automobile owner is giving more attention to the condition of the brakes on his car, owing to the increased necessity for efficient and rapid deceleration with the high-speed and quickly accelerated automobile of today. But, more important from the standpoint of brake-lining consumption, is the spread of free-wheeling among automobile manufacturers; this, according to recent tests and authoritative opinion, will be attended by a marked increase in the demand for brake lining. Such a result will follow not from any possible abuse of free-wheeling on the part of the automobile owner, but because of a more liberal use of larger brakes. Additional expense involved by this braking, of course, will be offset by the economies that free-wheeling affords.

Other recently announced new uses for manufactured asbestos products in the automobile field—none of which, however, can now be said to offer the possibilities that free-wheeling presents—include automobile bodies made of asbestos, and a fire-extinguishing asbestos cloth for motor-car use. For the asbestos motor-car body, a 50 per cent reduction in weight, as well as in cost, is claimed, besides the qualities of non-conductivity of heat, resiliency, protection against fire, and absence of the vibration effect commonly known as "drumming."

Asbestos raw-material producers, as well as asbestos manufacturing interests, will probably derive much encouragement from such developments. Certainly, both groups can well afford to co-operate with those promoting these expanded outlets.

The Prospector Is Worthy of His Hire

THE PROSPECTOR, particularly in a new and unexplored country, is a factor of importance in the mining industry second to none. But, because he usually plays a lone hand, and because he is, as a rule, without influence or much education, the instances in which he obtains his rightful share of the rewards are extremely rare. This is a tendency against which frequent and regular protest should be made. If left unchecked, it may well impede the course of systematic and thorough exploration.

A series of articles that appeared recently in the *Saturday Evening Post* commented on the fact that, of the original claim stakers on the Comstock Lode, only one retained even a tithe of the wealth that bonanza produced; the others squandered their shares in a short time. Today, the prospector has not even a chance to squander. All the devices of high finance are used in successful attempts to dilute his equity in a property. Sometimes the company or the individual by whom he is employed will sell his discoveries to another and allied group for a sum or for a number of shares representing a sum that is considerably less than a fair price. These practices are not considered dishonest, and examples by mining companies considered reputable in all other respects could be cited.

No wonder the paid prospector is inclined to loaf on the job; no wonder the independent prospector prefers to dicker with promoters of questionable ethics rather than with an established mining company. In Canada, where prospecting is frequently paid for on a day-to-day basis, with expenses included, many prospectors are content with creek traveling and claim staking in known mineralized country. As Messrs. Arnold and Robert D. Hoffman pointed out in an article on "Pre-Cambrian Conceptions," published recently, one consequence is that Canada is not yet adequately prospected, in spite of the tremendous publicity given to its natural resources in the last few years.

The policy of "doing" the prospector is no less short-sighted than that of paying labor a bare living wage. In the end it must militate against the interests of the employers, as a class, and of the community.

Another Mineral Byproduct Plant Reaches Production

SHIPMENTS of fertilizer from the ten-million-dollar Consolidated plant at Trail, British Columbia, started recently, but its manufacture is to be only one of the activities of an immense chemical unit. One of the most important products will be ammonia, an output of which, of more than 400 tons a day, is expected early in the fall. The initial section of the fertilizer plant will produce sulphuric acid, triple superphosphate, and mono-ammonium phosphate. An immense market is at hand in the Canadian wheat fields, a ton to every hundred acres. These lands cannot be *mined* for wheat indefinitely, bountiful as has been their production for many years.

Thus does Consolidated add to its prestige as one of the outstanding mining companies of the world, especially in point of variety of production. In spite of the immense possibilities of the Sullivan orebody, it is not a one-mine company. Copper, zinc, lead, silver, gold, cadmium from various properties; fluorspar for the acid plant from the Rock Candy mine; chrome from the Flint group, near Ashcroft; phosphate from the Crowsnest outcrop; sulphur dioxide from the smelter stacks; nitrogen from the air (the Fauser process is used); and a vast amount of power from the rivers of British Columbia—all are adapted to the requirements of mankind. The company's interests extend to almost every province of Canada, and to Alaska, the Northwest Territories, Labrador, Newfoundland, Washington, Oregon, Nevada, and Idaho, with active prospecting and examinations of ore deposits in this wide field.

Heretofore, Consolidated has expanded horizontally in the mining field, but the completion of the fertilizer and chemical plant is an important step vertically—in providing a product for the ultimate consumer. With the growth of the Canadian Northwest, metal-manufacturing facilities will no doubt be added.

The fertilizer plant is in part an outgrowth of the smelter smoke difficulty, long a cause of trouble to all concerned, and damage to vegetation. If the farmers would not accept the smoke free, the company decided to disguise it in the form of fertilizer and sell it to them for $50 a ton. Would that adversity could always be put to such good use by mining companies!

Deep Gold Mines and Geothermal Gradients

CANADA, not content with achieving a production of gold which surpassed that of the United States early this year, according to preliminary reports, seems to be trying to claim the honor of having the deepest gold mine in North America. Our newsy contemporary, *The Northern Miner,* says that the Kirkland Lake gold mine "is unique in that it is the deepest active gold operator in North America." When last heard from, the lowest working level at this property was the 4,300, and unless some lively sinking is going on while this is being written, our favorite for the present championship is still out on the old Mother Lode in California. There the Kennedy is down 4,950 feet from the surface, an auxiliary shaft from the 4,800 level extending 185 feet on the slope. When the sump has been sunk, the vertical depth will be about 5,000 feet. Nor is the neighboring mine, the Argonaut, far behind, at 4,805 feet, the lowest level being the 5,700, measured on the slope. Reference is to gold mines, of course. In some Michigan copper mines the depth reached is even greater.

Going back to Kirkland Lake, Doctor J. B. Tyrrell states that the temperature on the 4,300 is only 69 deg., the increment being about 1 deg. for every 150 feet in depth. Near the surface the temperature is always about the mean for that of the atmosphere where a mine is located—about 30 deg. at Kirkland Lake. This is fortunate for deep mining in northern Ontario. At the St. John del Rey property, in Brazil, the latitude is that of southern Cuba; and, though the mine is at an altitude of 3,000 feet, the rock temperature at current working depths of below 7,100 feet is such that a Carrier air-cooling system had to be installed underground a year or so ago. The geothermal gradient there has been about 1 deg. for every 140 ft., and at the deepest levels the rock, when opened was found to have a temperature of 127 deg. At the Kennedy, in California, the geothermal gradient was found to be 153 ft. per degree, giving a rock temperature of about 91 deg. on the 4,950 level. In some parts of the world, where hot springs exist or where the crust of the earth is apparently thinner, the temperature increase is two or three times as rapid as at the properties mentioned.

The economics of mining, unlike the economics of industrial manufacturing, is affected by factors the intensity of which may vary within wide limits. The problem of depth is not solely the problem of distance from the surface; but to those who encounter unusually difficult conditions underground may be offered the consolation that the research and initiative encouraged by such conditions are likely to produce effects of favorable and far-reaching consequence.

Providing Adequate Insurance Against Survival

STRANGE it is that industry, in considering insurance for its employees, should place major emphasis on the provision of benefit after the man is dead. The more insistent problem is: What is to happen when old age arrives. More attention is needed in the direction of insurance against survival, rather than insurance against death. Annuity provision on a reasonable basis can be obtained, as Mr. E. S. Smith points out in *The Nation.* As an example:

> Beginning at age 30, a man deposits $10.70 a month and continues this deposit until he reaches age 65, at which time he ceases to make deposits. The banks then begin to pay him an annuity of $1,000 a year, this payment to continue as long as he shall live. It will be observed that during the 35 years his total deposits have aggregated $4,494. It is evident that he will have received dividends back that amount to about $630, so that his life income of $1,000 a year has cost him net only about $3,864.

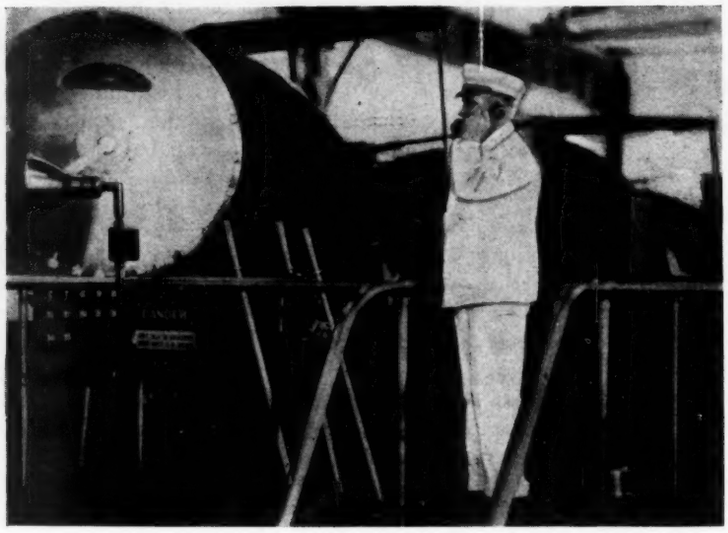
To most of those who have investigated the cost of annuity insurance, these figures appear too good to be true. Their accuracy is unquestioned, however, but to get such benefits one must be a resident of Massachusetts, where savings banks are permitted to write life insurance policies and old-age pensions. Even so, how can it be done? The answer is simple. Elsewhere, if insurance is needed, one has to pay for the excessive cost involved in soliciting and persecuting and persuading those who don't want it, the result of which is an appalling percentage of lapses. Despite the forfeiture to the insurance companies of large sums thus, the plan is obviously uneconomic, as the cost of ordinary life insurance indicates.

Savings' bank life or annuity insurance disposes of agents' costs and commissions. If a man wants a life-insurance policy or an annuity policy in Massachusetts, he goes to his bank and buys it; and the bank sells it to him at a reasonable rate, and profits thereby. The number of policies that lapse in Massachusetts are negligible. The rate charged is reported as about 26 per cent cheaper than that charged by commercial companies for ordinary life policies, and half the cost of weekly-payment policies.

Why should not the Massachusetts law be enacted in other states, thereby permitting the most logical agency, the bank, to undertake work for which it is entirely suited? Why should the individual who is ready and anxious to buy insurance be mulcted the cost involved in endeavoring to persuade others, who do not want to do so, to take out policies.

A major worry among the great bulk of wage earners is in regard to provision against survival and old age, not against decease. A fine opportunity exists for industry to help the employee by urging and securing the passage of legislation that would permit the enactment of the Massachusetts law elsewhere. Such a plan would be particularly welcome in mining towns. It would bring business to the local banks, it would stabilize employment, reduce necessity for charity. Above all, it would enhance confidence in local business and encourage adequate provision for old age. Mining companies might well take direct interest in such a move.

Safety Cage-Signaling System



In the hoist room. The operator is talking by telephone to the cage while it is in motion. Note the two loud speakers.

L. D. Stewart

AN INDUCTION SYSTEM of shaft signaling, which permits signals to be given from a position of safety on the mine cage, whether it is at rest or in motion, and which makes possible continuous conversation between cage tender and hoist man, has been dveloped at the Gogebic range iron mines of Oglebay, Norton & Company, Ironwood, Mich. I designed this system primarily to insure the safety of the person giving the signals by enabling him to give them from the cage after its safety gates and those on the station landing have been closed; also, to insure the safety of everyone on the cage once it is in motion, by permitting telephonic communication from the moving cage with the hoist man above, something not possible with ordinary signal systems. The system, moreover, makes possible economies in operating cage and skip hoists, especially for shaft work.

Cage tender talking to hoist man from inside the cage. Telephone is kept in top box, as indicated.

With the new system installed, the cage tender on the cage can signal or talk to the engineer at all times without leaving the cage. Another feature is a safety switch connected with the rope in the bonnet of the cage, which, normally open, closes whenever the rope slackens and automatically gives the stop signal. This is of advantage in the event of the cage becoming stuck in the shaft when lowering.

The wiring diagram of the system for both engine room and cage is shown in the accompanying drawing. The equipment required, costing in round figures about $250, is listed in the table. Save for the vibrator on the code signal on the cage, the equipment has no moving parts and should give little trouble. The only batteries used are on the cage and in the telephone circuits. They should easily last a year, the drain on them being light. Some of the tubes of the amplifier may require replacement within a like period. One of the photographic reproductions shows two loud speakers in the engine room. One of these, for the cage, is always in service. The other, for the skip, is in service as required.

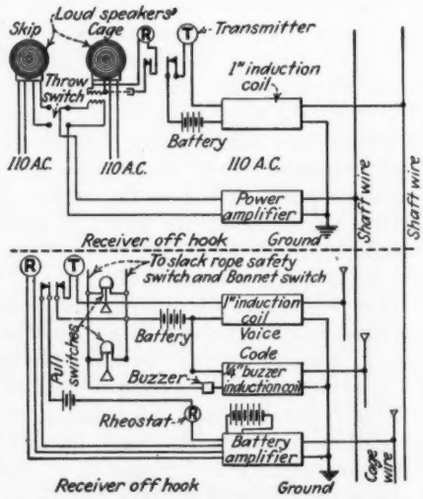
The system is flexible. As many signal switches as wanted may be installed, so that each deck may have one. Moreover, by installing an ordinary receptacle on the top deck and using a plug and switch, the switch may be carried outside of the cage on to the bonnet when work is being done in the shaft from the bonnet, using the old system. Shaft work nearly always requires at least two men, and perhaps as many as four, for giving signals alone. This system requires only the man on the cage.

In testing the system over a period of six to eight months a number of difficulties had to be ironed out before it would work satisfactorily under mine conditions. We believe that we can now say the system is a success.

Insulation is a factor that cannot be overlooked, especially on the aërials on the cage and particularly the high-voltage wire leading from the code signal to and including the aërial. The wire carries a high voltage which, if not insulated properly, is likely to break down and cause at least a partial failure of the system. Inasmuch as the operation of the system depends entirely upon induction, care must be taken to prevent induction between the different circuits.

Where the complete system is installed, using voice transmission both ways and code signal one way, two wires are required in the shaft. One is transmitting and the other receiving and they must parallel each other the length of the shaft. To cut down the induction between them, and thus avoid feedback currents, they must be placed as far apart as possible. Satisfactory operation, however, can be had at a separation of 2 ft.

We have found that we can connect the receiver on the power amplifier without getting too great a volume in the former. This is done by hooking the receiver circuit across the line between the transformer and the speaker coils in the speaker, and by using a 0.03 microfarad condenser in series with the receiver. This receiver circuit goes



Wiring diagram of cage and skip signal system described in text

Inside the cage, the operator using the signal switch to give code signal

through the switch hook, and both transmitter and receiver are cut out when the telephone is not in use. Instead of using a double-throw switch to throw on either speaker, it is thought best to keep the cage speaker cut in at all times with a switch on the skip speaker to cut it in or out as desired. The reason for having speakers on cage and skip is that when working in the shaft the cage is usually with the skip, and by a prearranged signal this can move either cage or skip at will.

Another point requiring attention in installation is that the loud speaker should be at least 8 or 10 ft. away from the telephone on the platform, which means that the speaker will be that far away from the operator, as the telephone must be located in a convenient place. The signal is strong enough to be heard at a much greater distance.

On the cage is shown 1½-volt battery in the switch-hook circuit, which lights the lamps on the amplifier whenever the receiver is taken off the hook. The signal switches on the cage can be as numerous as required, as they all bridge the line.

The aërial on the cage should be as long as possible. The closer it parallels the shaft wire, the stronger the signal. One wire in the shaft is used for the talking circuit of transmission and the code circuit of transmission. The other wire is used for the receiving circuit on voice. These aërial wires and in fact all wires should have a good grade of rubber insulation, especially the aërial wires and circuit on the cage. Our circuits are working perfectly on a 3-in. separation between aërial wires on the cage and the shaft wire. This arrangement allows for the side movement of the cage in operation and is close enough for first-class transmission.

This system is applicable to any type of shaft, whether inclined or vertical, except that in an inclined shaft more hangers will have to be installed to prevent sag. The types of supports used for the wire in the shaft depend entirely upon the shaft itself and the conditions existing. In the shafts sunk during the present era, most of them being vertical with steel sets, it has been found satisfactory to use ordinary side-supported trolley hangers hung inside of the H-section of the steel with a special piece bent in an ell shape and connected to the hanger by a long nut so that the clamp will clear the steel on the outside. These need be supported only once in a hundred feet. In our installations we are using No. 6 rubber covered and braided hard-drawn copper wire. In bringing the receiving and transmitting wires to the cage or engine room equipment, these should be kept as far apart as possible and come in from the opposite sides of the equipment if practical.

List of Equipment

Engine Room

1—A 37-50 Webster amplifier
1—0.03-microfarad condenser
2—227, 2—250, 2—281 tubes
1 or 2—No. 411 Magnovox dynamic speaker chassis
1—No. 1016 C-H Cradle hand set
4—Cond. cord to hand set
6—Cond. cord from stand
1—No. F-3683 induction coil (Central Scientific Company)

Cage

1—Special 2-stage battery, amplifier Webster
2—230 tubes
90 V. B battery, small
6—Dry cells
1—No. 51 Jeff. spark coil
Crouse-Hinds AF 10-gal. Condulet mine signal switch
1—No. F-3683 induction coil (Central Scientific Company.)
1—No. 1016 C-H Cradle hand set
4 Cond. cord to hand set
6 Cond. cord from stand
Trolley hangers and clamps
No. 6 hard-drawn R.C. wire

Power Amplifier Model A-37-50.

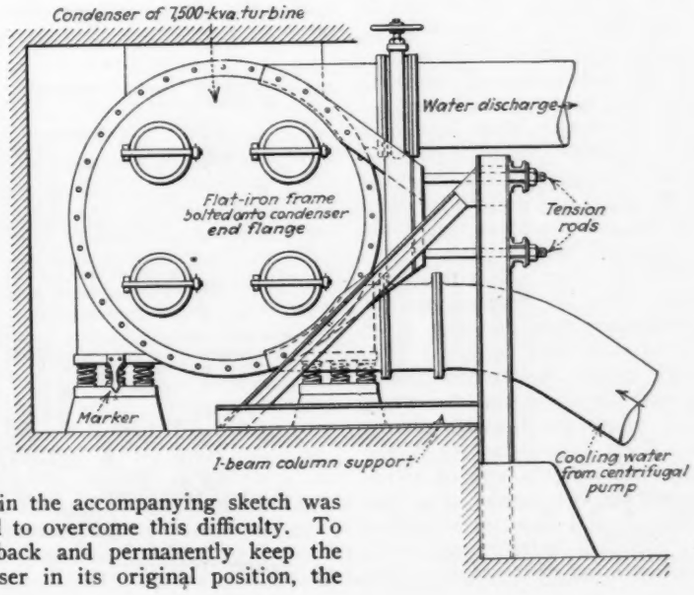
For engine-house receiving set
Tubes Used—First stage 1—227, second stage 1—227, third stage 2—250's, rectifier 2—281's.
Power Supply—110-v. 50- to 60-cycle alternating current. Consumes 150 watts.
Power Output—13 watts undistorted.
Speaker Field Supply—For one 1,000-ohm. dynamic speaker field. If A.C. speaker is used, amplifier requires Webster CR-241 choke unit.

Amplifier for Cage Receiving Set.

Tubes Used—First stage UX-230, second stage UX-230.
Power Supply—2 small-sized radio "B" batteries.
2 standard 1½ dry cells.
Output—To supply standard telephone receiver.

Keeping a Turbine in Perfect Alignment

AT THE power house of the New Cornelia mines of Calumet & Arizona, at Ajo, Ariz., alignment of the recently installed 7,500-kw. turbine was noticeably impaired after only a short period of operation. A careful inspection during a periodical shutdown revealed that the impact of the entering cooling water exerted a sufficiently high pressure at the condenser end to pull the entire turbine bed gradually out of alignment. To change the cooling water inlets and outlets on the condenser was found impracticable because of the high expenses involved, so the method illustrated in the accompanying sketch was devised to overcome this difficulty. To press back and permanently keep the condenser in its original position, the condenser end, subject to the water pressure, was fitted with a sturdy V-shaped frame, made of heavy strap and channel iron, containing four long, steel, tension rods, which anchor the condenser to the two channel-iron supports traversing the two I-beam columns installed a short distance from and parallel to the condenser. The condenser can thus be aligned at will by the operator, mere tightening of the four tension bolts being necessary. A small sheet-iron marker was placed on one of the condenser shoes to indicate any change in position.



Test-Plant Leaching of Oxidized Copper Ore

W. J. Loring

Description of equipment and results of experimental mills handling 1 ton and 15 tons per day, respectively, designed to demonstrate the advantages of the removal and separate treatment of slime prior to gravity lixiviation

THOUGH the leaching of copper ores has become fairly well standardized, the development of any new oxidized orebody must be accompanied by a considerable amount of metallurgical test work to indicate the various peculiarities of treatment that almost every ore requires. Often this early work goes unrecorded, and we read of the methods used in the large commercial plant only. But the laboratory work, the small test plant, and the experimental mill unit require thought and experience as well, and if this part of the work is well carried out, a great deal of money may be saved in the subsequent operations. It will be the province of this article, therefore, to describe the preliminary metallurgical work carried on at the property of a small Arizona company having a deposit containing a large prospective tonnage above water level. The method used in the test work is of general application for the solution of similar problems.

A 250-lb. sample of the ore was taken in the course of the mine development and analyzed. The indications were that nothing would interfere with leaching in cold dilute sulphuric acid. Several questions then arose, such as to what size should the ore be crushed, what would the acid consumption be, and how long a time should the ore be kept in contact with the acid to secure maximum economic extraction of the copper. These indicate only a few of the many things that had to be investigated.

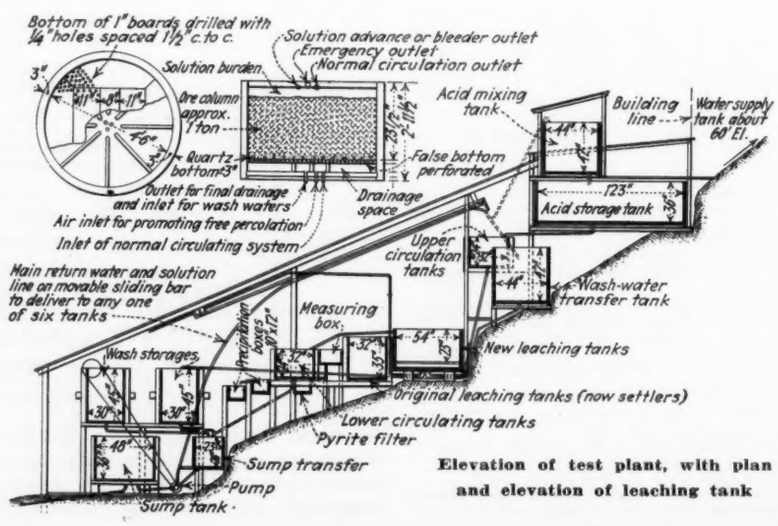
The first laboratory plant is shown in elevation in the accompanying figure. One section consists of six leaching vats each of which was designed to hold one ton of ore. At the upper end of the section is an acid storage tank a little over 10 ft. in diameter. Near this is an acid mixing tank. Next below are six upper circulation vats and the wash transfer tank, and then come six one-ton leaching tanks. Rectangular leaching vats were first provided, but these later acted as settlers for the effluent solution. Then come the six lower circulation tanks, at the end of which are a measuring box, settler box, two pyrite filters, and the precipitation launder. The wash-water storage tanks are at the lower end of the plant. Supplementary equipment included an ore bin, gas engines, crushers, transfer pump, and an air compressor with receiver. To convey the solutions from place to place by pumps would have cost some $2,000 for the pumping equipment alone had not provision been made in the design for gravity flow wherever possible and for quickly changing the intake and outlet of the one pump that was finally installed. The method of solution transfer may be explained as follows:

The row of solution tanks is set at an elevation of 6 ft. 8 in. above the bottom of the ore-leaching tanks. There are six tanks in each row, and each solution tank is connected to the ore-leaching tank with common 1-in. rubber hose. Each hose is fitted with a home-made pinchcock consisting of a bolt through one end of two pieces of wood 14 in. long; the hose is gripped between the other ends by means of a sliding iron ring. The hose is slipped over lead pipe projecting from each tank and fastened with ordinary iron wire, drawn tight.

The solution is led to the bottom of a leaching vat, percolates upward, and is then led into a lower circulating tank set 1 ft. 5 in. lower than the leaching tanks. When the lower circulating tank is full the solution is drawn into the sump transfer tank, from which it is pumped with a 1½-in. Duriron centrifugal pump, through 1½-in. rubber hose, to the upper circulating tank system. A sliding bar, to which the hose is attached, permits delivery over a length of 16 ft. to any one of the six tanks, merely by pulling a rope at the pump station. When the sump transfer is empty, the hose from the pump to the upper circulating tank is drained into acid-proof buckets, and the solution later poured back into the tank when pumping again to the same circulating tank.

This system of pumping is also used for the transfer of solution to the acid mixing tank and to acid storage, as well as for circulating wash water through the charges, from six wash-water tanks holding 200 gal. each. Extra coils of hose are provided for attaching to the regular hose when delivering to greater distances. One pump, with flexible outlets, thus does the work of several, and solutions are kept separate with dependable certainty.

The Douglas fir tanks are painted on the outside with several coats of boiling hot asphalt, especial care being taken to cover the iron hoops. Though not


Bottom of 1" boards drilled with ¼" holes spaced 1½" c. to c.
Solution advance or bleeder outlet
(Emergency outlet
Normal circulation outlet
Solution burden
Ore column approx. 1 ton
Quartz bottom 3"
Outlet for final drainage and inlet for wash waters
Air inlet for promoting free percolation
Inlet of normal circulating system
Drainage space
False bottom perforated
Acid mixing tank
Building line
Water supply tank about 60' El.
Acid storage tank
Upper circulation tanks
Wash-water transfer tank
Main return water and solution line on movable sliding bar to deliver to any one of six tanks
Measuring box
Precipitation boxes
New leaching tanks
Wash storages
Original leaching tanks (now settlers)
Lower circulating tanks
Pyrite filter
Sump transfer
Pump
Sump tank

Elevation of test plant, with plan and elevation of leaching tank

painted on the inside, they are in very good condition after three years' intermittent use, and show no more deterioration than would be expected if water only had been used in them. Their cost is considerably less than for lead-lined concrete tanks. The rubber hose has given no trouble, even at the places where the pinchcocks might have been expected to weaken it.

Various sizes of crushing were tried, ranging from ¼ to ⅝ in. Optimum results were secured by crushing to ⅜ in. This was done in two Dodge crushers, one set above the other with a grizzly between. This was made of ⅝-in. round iron rods, set at 40 deg., with the opening between the rods ¼ in. at the top and ⅜ in. at the bottom, to decrease blinding. The top, or primary, crusher was set to crush to ½ in. and the bottom one to ⅜ in. The second crusher product and the grizzly undersize were screened to ⅜ in., the fine material was thoroughly mixed, and shoveled into a 50-lb. dynamite box. Each shovelful was sampled with a metal scoop holding 3 oz. of ore, for copper and moisture assays. Each box was then hand-charged to the leaching tanks.

To insure an even distribution of ore in the tanks, 1x2-in. clear pine was nailed together to form a grating with spaces 2 in. square. This was placed on bearers radiating toward the center of the tank, the space between the tank bottom and the filter being 4 in. The filter is perforated with ¼-in. holes, spaced 1½ in., burned with a hot iron to insure a clear opening. A layer of quartz was placed on top of the filter to a depth of 3 in. before covering with ore. This quartz was crushed to ¾ in. and washed free of slime and sand. All solution flows were upward, as it was believed that control would be easier and that the ore charge would always be covered.

In the early work, consistent results could not be obtained, and the trouble was laid to the mechanical handling of the ore. The greatest care was used in charging to make a uniform bed, without success, the percolating solution appearing to bypass almost entirely some sections of the ore column. Finally, compressed air was introduced into the bottoms of the tanks, after rearranging the filter bottoms. This greatly helped the extraction. The object was not to agitate the charge, as that would be impossible, but to fill the charge with air and thus allow the free passage of solution, blocked by a concentration of fines, even though efforts had been made to avoid it.

The extraction on the first 29 charges averaged 63 per cent of oxide copper, with separate treatment for the fines and coarse. They arranged to use a 15-ton tank for the coarse and a Devereux agitator for the fines and slime. The first charge was wet-screened through 30 mesh and the second through 14 mesh, both giving excellent extractions. Then a trial with a charge with more fines was decided on; so a small drag classifier was made, with an endless belt and staggered drags about 1 ft. apart. It worked in a 12-in. box about 20 ft. long, and overflowed at 65 mesh. All ore was first crushed to pass the ⅜-in. square screen as in the other two charges. This gave a perfect percolation of the solution through the ore column and also maximum extraction, showing that it was the slime that gave the trouble.

For the first two charges the screen was placed over a water-tight tank, one end being submerged and the other projecting over the end of the tank. The ore was raked over this screen.

The fines and slime from these charges was treated in a Devereux agitator and 93 per cent of the oxide copper dissolved in four hours.

Classification in solution was next decided upon. For this purpose a larger drag classifier was made, one which would classify a 15-ton charge in a short time. This was placed in position over

Comparison of Operating Results

	One-Ton Charges			Fifteen-Ton Tank Charges				Average of Six Agitator Charges
	Nos. 30–39, Average	Nos. 40–49, Average	Nos. 50–73, Average	Charge No. 1	Charge No. 2	Charge No. 3	Charge No. 4	
Feed, % total copper	2.37	2.40	1.95	2.19	1.98	1.82	2.42	1.90
Feed, % oxide copper	2.16	2.15	1.80	2.03	1.79	1.65	2.19	1.72
Tailing, % total copper	0.46	0.37	0.30	0.26	0.275	0.25	0.37	0.26
Tailing, % oxide copper	0.29	0.20	0.17	0.12	0.125	0.11	0.20	0.107
Extraction, % total copper	80.30	84.60	85.10	88.10	86.10	86.30	84.75	86.30
Extraction, % oxide copper	86.40	90.50	90.80	94.10	93.00	93.30	90.80	93.90
Feed, plus-6 mesh, %	44.20	48.00	42.40	44.40	48.90	42.60	.....	All ore from 14 to 65 Mesh
Feed, plus-40 mesh, %	40.00	38.90	41.50	50.00	47.90	48.50	.....	.....
Feed, minus-40 mesh, %	15.80	13.10	16.10	5.60	3.20	8.90	.....	.....
Lb. acid per pound copper extracted	1.92	1.92	2.06	1.92	1.79	1.83	1.60	1.79
Average acid content of leach solutions	1.91	2.09	2.20	2.57	1.90	1.82	2.09	1.79
Average copper content of leach solutions	2.04	1.76	1.28	2.06	2.51	1.10	2.10	0.90
Average time of leach, days	8.00	6.00	7.30	6.00	4.40	3.20	5.60	4.30 hours

top of the round leaching tanks, and exactly one ton of ore poured through. A complete log was kept of each charge. The tanks were discharged by removing a 4-in. layer at a time with a square-pointed shovel, careful observations being made and special samples occasionally taken in addition to 3-oz. samples already mentioned for the feed. The sample was deposited in a white enamel bucket and tested for moisture and for both soluble and insoluble copper. Screen tests were made of every charge treated, both before and after leaching.

The flow of the solution passing through the ore was measured every half hour. As a check against these half-hourly samples, and to ascertain the exact amount of solution going to the precipitation plant, a tank was constructed, and arranged so as to hold all the solution for an eight-hour shift, at which time it was measured, sampled, and turned into the precipitation plant.

The filter bottoms were made of 1-in. full, clear, soft pine, and set upon varying from 36 to 88 per cent. These figures include five charges using compressed air, but not in the proper way. In the next twenty charges, with a better arrangement for the use of compressed air, the average extraction was 88 per cent, the lowest in this series being 80 and the highest 96 per cent. In the next series, from 50 to 73 inclusive, the average extraction was 91 per cent of the oxide copper, varying from 71 to 95 per cent. Faulty filter bottoms in three tests pulled down the average. Coco matting, or any covering, interrupted free circulation of the solution and was ineffective. After these bottoms were remedied, the lowest extraction was 92 per cent.

Use of compressed air to assist the circulation of solution through the charge resulted in the accumulation of much slime in the chamber under the filter bottom, which took time for its removal. It had been thoroughly leached of its copper content. The solution was muddy, also, so those in charge of operations decided to try classification, the 15-ton tank and the coarse material discharged directly into the tank, the fine sand and slime overflow, which came off at 65 mesh, going to the agitator. During the classifying operation 73½ per cent of the copper was extracted from the fines and 17 per cent from the coarse, which, as in other charges, had been crushed to pass a ⅜-in. screen. A considerable amount of 200-mesh slime ran over the coarse-ore discharge end of the clasifier in this test, concentrating in a small area of the tank and causing a poor circulation of the solution. The extraction, therefore, was only 91 per cent of the oxide copper.

The accompanying table gives a summary of results of the test runs and shows the effect of classification in giving better extractions and cutting down the time of treatment.

Analyses of the tests proved that by removing the fine material in acid solution the extraction was speeded up by at least four days compared with the early work. The ore from this property seemed ideal for leaching except for the

presence of colloidal slime, which could not be treated efficiently along with the coarse. The extraction in the agitator was accomplished in only a few hours, and in the leaching tank in a fraction over three days. This would mean a great saving in the first cost of a leaching plant. Quick treatment also saved sulphuric acid, as the acid had less time to attack acid-consuming ore minerals, though these were not present to any extent.

As a result of the test work, a plant has been designed to treat a total of 600 tons a day in nine tanks, each having that ore capacity. Present plans provide for the classification of the crushed ore in Dorr duplex acid-proof classifiers mounted on a track over the leaching tanks, all in one line. These classifiers will be moved by a car puller to the tank to be charged. The dry ore, crushed to $\frac{3}{8}$ in., will be fed into the classifiers by a tripper, mounted on and traveling with the belt conveyor. The fines will be conveyed to settlers by a launder running parallel with the tanks. Classification will be done in standard acid solution, thus saving at least one shift in the time of leaching in the tanks. Laboratory tests show that minus-150-mesh ore will give up over 93 per cent of its oxide copper in less than five minutes.

In all this work I have been ably assisted by A. L. McFarland, chief metallurgist, and E. L. Sweeney, consulting engineer. Local checking was done by A. L. Blackburn. The design of the test plant was very successful. Results in the one-ton plant were checked by a 15-ton tank, which gave the same extraction. The smaller test plant is recommended as details of treatment can be changed more rapidly than with a 15-ton plant. After all, the treatment of copper ores by leaching is not materially different from the treatment of gold ores by the cyanide process. Copper really presents an easier problem. The slime can be treated by counter-current decantation, like gold, but in acid-proof equipment. Mechanical handling and preparation of the ore is important, and of course at the very first one must be certain that the ore does not contain an undue amount of acid-consuming substances.

The total cost of a treatment plant for 600 tons a day, as indicated in this paper, was estimated at $240,000, including everything from rock crushers to the tailing disposal plant, or $400 per ton of daily capacity.

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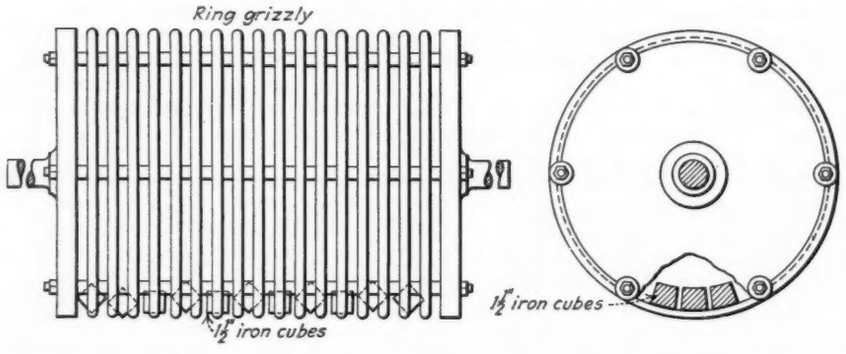
Cleaning Ring Grizzlies

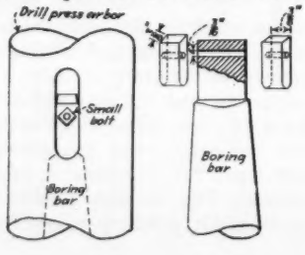


WET or sticky ores that block passageways, feeders, and grizzlies cause trouble and expense at the crushing plant and mill, extra men being constantly required to clean the grizzlies and feeders to maintain the required flow of ore to the grinding units. The Moctezuma Copper Company, Nacozari, Sonora, Mexico, confronted with a similar problem during the rainy season, avoided such difficulties at the crushing plant, equipped with ring grizzlies, by placing about 24 1½-in. iron cubes into the ring trommel, as shown in the accompanying sketch. The vibration of the grizzly rings, caused by the hammer-like action of the cubes, removes instantly any accumulation of ore particles between the grizzly openings.

■ ■

Long Lathe Boring

WHEN boring long machine parts in the lathe, correct set-up and adjustment of the drill and boring bar are most important, writes Charles Labbe. A perfect bore and the avoidance of tool vibration can be obtained by placing the steadyrest near the object to be bored out and employing it as a tool support or bearing, the boring bar or drill resting between the adjusted jaws of the steadyrest. Because of the grooves the twist drill contains, a solid or split bushing, protected by a close-fitting felt or canvas washer to prevent the turnings from entering the guide bushing, must be provided when using a twist drill. To prevent the boring bar from falling out of the tail spindle or drill press spindle, the tongue of the taper shank is lengthened to afford space for a $\frac{1}{16}$-in. hole. Then two small mild-steel keys are prepared, each of which is also fitted with a $\frac{1}{16}$-in. hole. These are placed into the key slot of the spindle and pressed to the shank tongue by a $\frac{1}{16}$-in. bolt, as shown in the accompanying sketch.

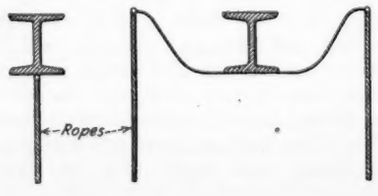


Chattering may be caused by a tool that is too wide and not well supported, or by excess cutting speed, or a feed not in accordance with the cutting speed. For finishing, a boring bar equipped with a tool cutting from both ends is preferable. When boring out a taper, the cutting edge of the tool must be central and also follow the center line; otherwise, a different taper angle will result.

■

Low Clearance Warning Prevents Accidents

A DEVICE to bring to a worker in the plant a realization that a hazard is imminent consists of a series of short lengths of rope hung from a low-clearance projection. To warn, this signal must be seen. A better arrangement provides for ropes ahead of the danger point, and arranged so that the walker comes in contact with them even if he does not see them. The latter plan is used successfully by railroad companies. Both methods are shown in the accompanying illustration.



NATURAL GAS—

A Fuel of Increasing Importance in the Mining Industries of the United States

A. H. Hubbell
Associate Editor

UNUSUAL activity in the construction of pipe lines for conveying natural gas from the sources of production to many communities in the United States where this fuel has not hitherto been available marked an advance in 1930 still in evidence. In many instances the distances covered are considerable. One of the causes of this activity is a belated realization on the part of capital and of public officials of the way in which an important natural resource was being wasted. This influence has been heightened by the discovery of new large reserves of gas; and the expansion has been made economically possible by the development of improved methods of laying pipe lines over long distances and of making large pipe more cheaply.

Gas, natural and manufactured, having long been a fuel for metallurgical work and in producing power consumed in connection with such work, the mining industry is concerned with these developments, to the point, at least, of determining whether or not the operator, or the engineer engaged in planning a new project, can count on the availability of natural gas as fuel, and on what basis.

Where gas has hitherto been obtainable, interest will be confined to learning if gas is to be cheaper. If good coal or fuel oil at a low price, or cheap power, is available, interest may be slight, though these circumstances do not necessarily mean the exclusion of gas as fuel. The proposal to bring gas into such a district may have the effect of lowering the price of other fuels. This interest of the mining industry in the possible significance of these new developments is paralleled by a reciprocal interest on the part of those engaged in distributing and marketing natural gas, who would like to know the extent of the possible market for their gas at mines and smelters. They know that they have in gas a fuel possessing advantages over coal and oil; but they are aware that unless they sell it at a price attractive to the prospective customer, the latter will continue to use coal or oil, as may be most convenient and practicable. If the extension of a pipe line into a district is under consideration, the consummation of a proposal will depend largely on the comparative prices of competing fuels. Instances can be cited of metallurgical companies using gas in territory where good coal or oil is obtainable, and still other instances where smelters are burning coal or oil in gas-producing regions. If the smelting or mining operator is also a coal producer, the price of gas will have to be unusually attractive to induce a change.

Advantages of gas as fuel are that it is clean and easy to handle, being superior on these counts to other fuels. Compared with coal, its adoption may make possible a saving in labor cost. Moreover, its use does not tie up money in fuel stocks. The amount consumed can be varied with little trouble, whereas to increase the amount of fuel oil burned may call for planning in advance. In some cases, the use of gas will permit a substantial saving in fuel cost with practically equal efficiency per B.t.u., though it is not necessarily the cheaper fuel. Experience at smelters where gas has been substituted for coal indicates that the change entails no difficulty.

Gas has been used for many years at some of the zinc smelters in the Middle West. The 1929 Year Book of the American Bureau of Metal Statistics reports it as being employed at the plants at Bartlesville, Blackwell, Henryetta, and Quinton, Okla.; at Cherryvale and Caney, Kan.; at Amarillo, Tex.; and at Fort Smith and Van Buren, Ark., the plant at the last place having been idle in 1929 and 1930. It is being used to a limited extent at Langeloth, Pa., for reducing zinc ores; at Galena, Kan., for lead refining; at the reduction plant at East St. Louis, Ill., where it was adopted in 1930, and possibly at various other Mid-Western plants the practice of which, owing to an unfortunate atmosphere of secrecy, is ascertainable only with difficulty, if at all. Gas has been in use for some time at the El Paso smelter, as described in *Engineering and Mining Journal*, June 7, 1930. Recently it has been adopted to a varying extent in Utah, at the Salt Lake Valley smelters, though good coal at a fair price is available.

The industrial applications of natural gas are varied at the plants indicated in the foregoing. At the El Paso smelter it is used for all lead and copper operations. At various other Western lead and copper smelters it is being used on boilers, drossing reverberatories, Godfrey and Wedge roasters, Dwight & Lloyd sintering machines, lead-drossing kettle furnaces, McDougall calcining furnaces, in the acid plant, on laboratory furnaces and hot plates, for thawing, and for general heating purposes. A Mid-Western zinc smelter (and doubtless others) is burning gas on its (Herreshoff) roasters, on condensers and retort kilns and on its boilers. The plant at Langeloth, Pa., uses it in the ignition burners of the Dwight & Lloyd machines as the regular supply of fuel, and to start the multiple-hearth roasters and to maintain temperature during interruptions of the feed. This recital will suffice to show the status in 1931 of the scope of the application of natural gas in metallurgical work in the United States. The possibility of a more extensive use in reducing zinc ores is indicated in the recent announcement by the Bureau of Mines, to the effect that C. G. Maier, a member of the Bureau's staff, has developed a practical and economic method of treating low-grade ores with methane, or natural gas.

To what extent, if any, is the mining industry likely to benefit or be otherwise affected by the extension of gas pipe-line facilities now in progress? The possibility of the wider use of natural gas in smelting zinc ores has just been mentioned. Aside from this, what mines and plants are likely to have gas brought to them? Do any of these plants lie along or near the routes of the gas trunk lines now under construction or projected?

A map of the United States will show that the non-ferrous metallurgical plants of the country are grouped (broadly speaking) for the most part in certain areas. These are: (1) the Atlantic seaboard; (2) southwestern Pennsylvania and northern West Virginia; (3) Illinois, western Indiana, and the St. Louis district of Missouri; (4) the

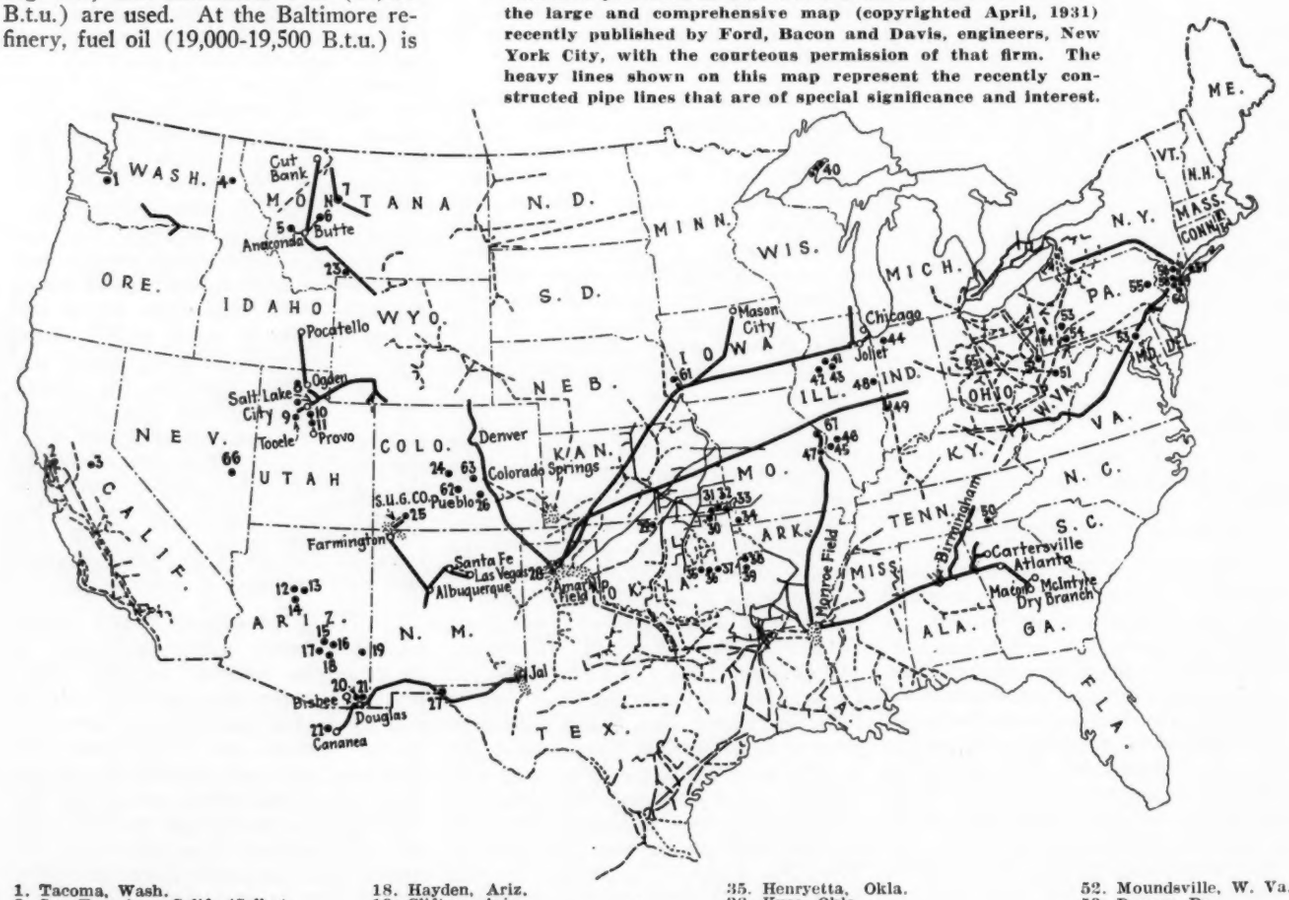
Tri-State district and near-by parts of Oklahoma and Arkansas; (5) the South, including Alabama, Georgia, and Tennessee; (6) the Southwest, including El Paso, Amarillo, and central and eastern Arizona; (7) the Salt Lake Valley; (8) the Butte-Anaconda district of Montana.

Plants on the Atlantic seaboard are burning coal or oil, or both. Although manufactured gas is available at each, its use is confined to the laboratory of one New Jersey smelter. No gas producers are used. Of the New Jersey plants, that at Carteret is burning slack coal of 14,500 B.t.u. quality. At Perth Amboy, pulverized bituminous coal (14,000 B.t.u.) is used for firing the reverberatories and under boilers. Fuel oil (28 deg. Bé. or higher, and 19,000 B.t.u.) is used on the small reverberatories and retorts of the silver refinery. The main blast furnace fuel is 48-hour coke, plus a certain amount of anthracite (14,000-15,000 B.t.u.) used to lower the copper content of the slag, resulting from treating certain by-products. At Maurer, both fuel oil (14 deg. Bé.) and bituminous coal (14,200 B.t.u.) are used. At the Baltimore refinery, fuel oil (19,000-19,500 B.t.u.) is employed for making steam and melting copper. Although a pipe line (formerly an oil line) is already in existence between the western New York-Pennsylvania field and Newark, N. J., and delivery of gas to the metropolitan area is under consideration, and a line to Baltimore and Philadelphia from the West Virginia field is already built as far as Washington, these projects have had no effect on the fuel situation at the seaboard metallurgical plants. However, the proximity of the recently discovered reserves of the Tyrone-Tioga (New York-Pennsylvania) field, the largest found in the East and now yielding 100,000,000 cu.ft. of gas per day, may cause extensive changes in industrial habits as to fuel in New York, New Jersey, and Pennsylvania.

A network of pipe lines traverses the Pennsylvania-West Virginia territory. Despite this, the zinc smelters at Donora and Langeloth, Pa., and at Meadowbrook and Moundsville, W. Va., are using coal as fuel, at least for their principal operations. Natural gas is employed to some extent, the plant at Langeloth using it in its sintering machine to ignite the charge and to start the roasters and maintain temperatures during interruptions in the feed. The Moundsville smelter is now roasting with natural-gas-fired Herreshoff kilns, instead of with Matthiessen & Hegeler kilns fired with producer gas (derived from coal) as formerly, the rate matural gas prohibiting the use of this fuel on the latter. Could natural gas be obtained at a price equaling the cost of the producer gas, this operator would be glad to use it on the Hegeler furnaces. However, this seems too much to expect at present. In this area, where good coal is cheap, natural gas has strong competition.

The plants in the third field mentioned, comprising Illinois and the adjacent

Map showing approximate geographical relationship of the primary non-ferrous metallurgical plants and metal-mining regions of the United States to the network of natural-gas pipe lines (existing and under construction). The pipe-line data here presented in abbreviated form have been taken from the large and comprehensive map (copyrighted April, 1931) recently published by Ford, Bacon and Davis, engineers, New York City, with the courteous permission of that firm. The heavy lines shown on this map represent the recently constructed pipe lines that are of special significance and interest.



1. Tacoma, Wash.
2. San Francisco, Calif. (Selby)
3. Copperopolis, Calif.
4. Kellogg, Idaho
5. Anaconda, Mont.
6. East Helena, Mont.
7. Great Falls, Mont.
8. Garfield, Utah
9. Tooele, Utah
10. Midvale, Utah
11. Murray, Utah
12. Clarkdale, Ariz. (Jerome)
13. Clemenceau, Ariz. (Jerome)
14. Humboldt, Ariz.
15. Globe, Ariz.
16. Inspiration, Ariz.
17. Superior, Ariz.
18. Hayden, Ariz.
19. Clifton, Ariz.
20. Bisbee-Warren, Ariz.
21. Douglas, Ariz (two plants)
22. Cananea, Sonora
23. Cooke, Mont.
24. Leadville, Colo.
25. Durango, Colo.
26. Pueblo, Colo.
27. El Paso, Tex.
28. Amarillo, Tex.
29. Blackwell, Okla.
30. Bartlesville, Okla.
31. Caney, Kan.
32. Cherryvale, Kan.
33. Galena, Kan.
34. Grandby, Mo.
35. Henryetta, Okla.
36. Kusa, Okla.
37. Quinton, Okla.
38. Ft. Smith, Ark.
39. Van Buren, Ark.
40. Lake Linden, Mich.
41. La Salle, Ill.
42. Peru, Ill.
43. Depue, Ill.
44. East Chicago, Ind.
45. East St. Louis, Ill.
46. Collinsville, Ill.
47. Herculaneum, Mo.
48. Danville, Ill.
49. Terre Haute, Ind.
50. Copperhill, Isabella, Tenn.
51. Meadowbrook, W. Va.
52. Moundsville, W. Va.
53. Donora, Pa.
54. Langeloth, Pa.
55. Palmerton, Pa.
56. Newark, N. J.
57. Laurel Hill, L. I.
58. Perth Amboy, N. J.
59. Chrome, N. J.
60. Carteret, N. J.
61. Omaha, Neb.
62. Cañon City, Colo.
63. Colorado Springs
64. Josephtown, Pa.
65. Columbus, Ohio
66. McGill, Nev.
67. Alton, Ill.

portions of Indiana and Missouri, have, with one exception, heretofore been without natural gas. They are situated at East Chicago and Terre Haute, Ind.; at La Salle, Peru, and Depue, in north-central Illinois; at Danville, in the eastern, and at Collinsville, Hillsboro, and East St. Louis, in the southwestern, part of the latter state. Gas has recently been made available at East St. Louis by the Mississippi River Fuel Corporation through that company's pipe line from Monroe, La., and is being used under steam boilers and for various metallurgical purposes at the plants there. The cost of coal (screenings, 30 per cent volatile and 49.5 fixed carbon), delivered in this locality, is $1.20, and that of fuel oil (19,000 B.t.u. and 32 to 36 deg. Bé.), 4c. Doubt is expressed as to whether or not natural gas can compete economically with this coal as boiler fuel. Producer gas made from the coal in Morgan producers is being used at this point on the zinc-retort distillation furnaces. Rumor has it, moreover, that natural gas will be obtainable at a competitive rate at Hillsboro in the near future. The smelter at this point, however, is said to have investigated the possibility of using it, the result so far being that the gas apparently would cost more than the coal and fuel oil now in use. Whatever the outcome, the deciding factors will be relative cost coupled with the possibility of making a better product.

Likewise at Danville, Ill., a gas supply is to be brought into the district, though the smelter there claims to have no plans as yet for using it. The pipe line is being built by the Missouri Kansas Pipe Line Company from the Amarillo field, in Texas, and the Hugoton field, in southwest Kansas, and will run as far as Indianapolis. The smelting company at Danville mines its own coal to make producer gas. La Salle will eventually have natural gas available. A line of the Continental Construction Corporation (see map), bringing gas from the Amarillo field to Joliet, Ill., and Chicago, will pass near. This line is already built as far as the Missouri-Illinois boundary. If desired gas can evidently be supplied from this line to Peru and Depue. The smelting company at La Salle, however, has a good coal, which it mines at a cost of about $2 per ton, and is said to see no advantage in switching to natural gas at the price at which the latter is being offered. Inasmuch as this company is using producer gas, made from its coal in Hegeler producers, it could readily change to natural gas if the price of the latter were attractive. Fuel oil (16-20 deg. Bé.) is also available in this locality at $1.25 per barrel, delivered. No natural gas is being consumed at Depue, and the possibility of using it is said to have received no consideration. A branch line from Joliet to Milwaukee is contemplated. The plant at East Chicago will have a gas supply available, if wanted, at no great distance.

Proceeding to the westward, the next cluster of metallurgical plants encountered is that of Oklahoma, Kansas, and Arkansas. Throughout this area, natural gas has been and is being widely used. All zinc smelting plants within its boundaries are using it as fuel. An increased supply of gas in Oklahoma is said to have resulted in lowering prices several cents, which may cause prices elsewhere to come down. The plant at Quinton, Okla., purchases its gas (1,040 B.t.u.) from the Central States Power & Light Corporation at a 6c. rate. Good coal is also available. At Blackwell, where smelting operations are temporarily suspended, the normal consumption is 9,000,000 cu.ft. daily (1,000-1,050 B.t.u.) purchased from Harris & Haun, of Blackwell. The pipe lines of two other companies, the Consolidated Gas and the Empire, are a short distance from the plant, this seeming to insure an adequate future gas supply. Gas has been available at Henryetta for fifteen years. The smelting company there produces its own gas, of about 1,000 B.t.u.'s. in quality, at a cost of about 8c. No other fuel is used. At Van Buren, Ark. (7 miles from Fort Smith), where the local zinc smelter is now shut down, operations are normally dependent on natural gas (990 B.t.u.) supplied by the Twin City Gas Company, of Fort Smith, about 4,000,000 cu.ft. being consumed daily at full capacity. Gas has been available in this locality for many years. Sold at 10½c. in 1929, it might possibly be had today for less. New gas territory is said to be available, and a surplus of gas already exists, so apparently gas will continue to be abundant for industrial uses in the future. The smelter at Fort Smith pays a 10c. rate for 1,000 B.t.u. gas supplied by the LeFlore County Gas & Electric Company. Coal of 12,000 or 14,000 B.t.u. quality is available at $3.50 to $5 per ton.

In the Southern territory comprising the Birmingham district of Alabama, also that part of Georgia tributary to Atlanta, and the State of Tennessee, are several metal-mining and smelting projects of importance (aside from Birmingham's iron mining and metallurgical industry), and numerous non-metallic operations. Until recently, Georgia and Alabama have been without a supply of natural gas. A pipe line has been constructed, however, by the Southern Natural Gas Company, from the Monroe field, in Louisiana, through Birmingham to Atlanta. The prospective industrial and domestic lighting and heating market of the two large communities traversed was the incentive for this project. The gas is approximately 1,000 B.t.u. in quality. It will have to be sold in competition with the abundant excellent local coal of this region. At Adairsville, on the Nashville, Chattanooga & St. Louis Railroad, between Atlanta and Chattanooga, it has replaced coal in a tile plant. Near by, at Plainville, on the Southern Railroad, tests are being made with a view to replacing coal with gas as fuel in the kilns of a large brick-making plant. Branches from the line are to supply the Cartersville mining district, north of Atlanta, and the Dry Branch and McIntyre districts, near Macon.

North of Atlanta, 112 miles away, is the Ducktown Basin of Southeastern Tennessee, with two large enterprises, each comprising mines, a mill, a smelter, and an acid plant. Extension of the line from Atlanta to this area is not beyond the bounds of possibility. Here, as elsewhere, the critical factor will be the cost of gas. Doubt is expressed that foreign gas can be brought to Tennessee at a price low enough to interest the mining companies. The Tennessee Electric Power Comppany has two hydro-electric plants with a standby steam plant within 25 miles of Ducktown. These are interconnected with the plants of other companies. An extension of the Southern Natural Gas Company's line to Chattanooga is reported to be in service.

Tennessee has three small gas-producing fields, with a capacity estimated roughly at 15,000,000 cu.ft. The oldest is in Scott and Morgan counties, on the Northern Cumberland Plateau. Another is near McMinnville, 70 miles east of Nashville, and the third is in Lincoln County, about 80 miles south of Nashville. The Missouri-Kansas Pipe Line Company, through a subsidiary, has franchises extending through Tennessee counties from Kentucky to Nashville.

A region that is seemingly remote from natural-gas resources is the Lake Superior iron and copper country. Now dependent on coal, shipped in for the most part by Lake, and on hydro-electric power, it seems likely to remain so, at least for some time. Nevertheless, a pipe line is being run by the Continental Construction Company from the Amarillo field to Omaha (where the gas will probably be given consideration at the local smelter), and beyond this point another line will deliver gas as far as Mason City, in northern Iowa. Extension of this system to Minneapolis is doubtless merely a matter of time. A line from Joliet to Milwaukee is under consideration, as already stated. With the completion of the pipe lines mentioned, the distance between the Lake Superior mining region and natural-gas supply will be considerably shorter.

Various points in Colorado, including Pueblo, Colorado Springs, and Denver, are now supplied with gas from the Amarillo field by a pipe line of the Colorado Interstate Gas Company and Canadian River Gas Company, built in 1928. Another line shown on the map connects Denver with Cheyenne, passing through the small Fort Collins

field. Apparently, most of Colorado mining camps will remain without gas for a long time. In the southwestern part of the state gas is available at Durango (where the smelter is now shut down) from the San Juan Basin field, which is mostly in New Mexico. From this field a line of the Southern Union Gas Company runs to Albuquerque, Sante Fe, and Las Vegas, N. M.

Natural gas, of a rated 950 B.t.u. quality, is available at a 5c. rate at Amarillo, in the Texas Panhandle, where it is supplied to the local zinc plant by the Huber Petroleum Corporation. In this region, where gas has been obtainable since 1917, is to be found one of the country's major gas fields. Colorado coal of good quality is also to be had at $7.60 to $9 per ton at Amarillo; likewise fuel oil, of 24-30 deg. Bé. gravity, at about $1.50 per barrel delivered.

In the Southwest, the El Paso smelter is the only unit of the mining industry having a supply of natural gas at present. The gas is brought by the El Paso Natural Gas Company from the Jal field, in the southwest corner of New Mexico (extending across the state line into Texas), and was introduced in 1929 to compete with fuel oil, then selling at $1.80 per barrel. In consequence, the price of oil was lowered, and it is now selling at $1. Rumor has it that an 18c. gas rate is obtainable by large users in El Paso.

Early in 1931, plans were completed to extend the pipe line system beyond El Paso. A 275-mile line was projected to run to Douglas and Bisbee, Ariz., and to Cananea, Mexico, via Deming, N. M. This will be constructed by the Western Gas Company, a subsidiary of the El Paso company. The rate at which the gas will be sold at Douglas is rumored to be in the neighborhood of 22 to 23c., equivalent to oil at $1.10 per barrel. A contract, effective Aug. 1 next, when the gas is to be in use, has been signed by the Calumet & Arizona Mining Company for the use of gas for reverberatory smelting and mining operations at a rate not to exceed 12,000,000,000 gross B.t.u. per day. Use of gas for smelting operations and power production is expected to effect a substantial saving in fuel cost with practically equal efficiency per B.t.u. No coal is used under boilers or in reverberatories in this field, fuel oil from Texas and California selling at present at $1.54 per barrel, f.o.b. plant, being available. The cost of switching the four reverberatories to the new fuel, including piping, valve, burners, and metering and testing equipment, is estimated at about $54,000. Another large company is reported to be party to the present arrangement and to have arranged to start using gas, instead of oil, for fuel on the same date. Rumor also has it that a Diesel power plant in the Southwest will be operated on gas instead of oil, such change having been found feasible and practicable from the mechanical viewpoint, with certain minor changes in the machinery. The efficiency will be equal to that obtained when burning oil, it is said.

Such pending events as those recited have been made the basis for other rumors about the extension of gas facilities to various Arizona points, such as Phoenix and Globe, the implication being that the trunk line would be tapped or extended to supply the principal mining camps and metallurgical plants in the state. These rumors do not seem to be based on fact, though some inquiries and negotiations appear to have been made. Much lower rates on gas would have to be quoted than have thus far been mentioned, it is said. At Jerome, a deterrent would be the apparent short life of the United Verde Extension Company's mine, and the fact that the company has its own coal mine at Gallup, N. M. At Clarkdale, sub-bituminous coal (10,500 B.t.u. wet) is available at $4.50 per ton, f.o.b., and fuel oil (6,200,000 B.t.u.'s per barrel) at $1.67 f.o.b. per barrel.

Increased use of natural gas at various mines and plants in California would occasion no surprise, in view of the state's abundance of this resource. Its distribution is almost exclusively in the hands of the utility companies, whose policy appears to be to supply power plants and domestic consumers and then to devolop local industries. At the Selby smelter, on San Francisco Bay, the question of switching from fuel oil, costing 89c., to natural gas (1,100 B.t.u.) has been considered, thus far with no decision. Delivery to this plant would be quite simple. Here coal costs $16. In general, in this area, insufficient time has elapsed for widespread industrial use of gas. In the Los Angeles area, the chief gas-consuming section, most of the brick and pottery kilns are using it for fuel. At Stockton, a local firebrick company is using oil, the terms for gas being unfavorable at this point, but the same company is burning 400,000 cu.ft. of gas per day at its plant at Pittsburg. At the latter point the Columbia Steel Company is using gas to some extent. For the most part, the cement, gypsum, and magnesite companies are burning oil, being out of the pipe-line net. The non-metallic industries that might naturally be expected to turn to gas for fuel include the gypsum industry (for calcining kettles), cement (for kilns and dryers), and the magnesite and refractory brick industries (for kilns). Mining companies in the hills appear likely to continue using oil, because of the low price of the latter and their comparatively modest fuel requirements.

Remaining for consideration are the plants of the Salt Lake Valley and of the Northwest. In the Salt Lake Valley, since 1929, natural gas has been brought in from the Wyoming fields south of Rock Springs by the Wasatch Gas Company and is being used to a varying extent by the smelters of the region, thus far with satisfaction, according to report. This gas is supplied to Salt Lake City, Ogden, Tooele, Murray, and other small towns in the vicinity of Salt Lake City. Plans are under way to extend the pipe lines to Provo and to Pocatello, Idaho. The necessity of competing with the excellent Utah coal seems to be no deterrent. To the mining districts bordering the valley, where fuel requirments are sufficiently large, the near-by gas facilities may some day prove inviting.

In Montana, late in February last, contracts were signed by the Anaconda Copper Mining Company and the Montana Power Company for the consumption and domestic distribution, respectively, of natural gas to be brought from the Cut Bank field, in the northern part of the state. This gas will be produced and transported by L. B. O'Neil, of Cut Bank, Mont., and delivered to the Power Company for distribution in a quantity of 10,000,000,000 cu.ft. per year. In quality it is somewhat better than 1,000 B.t.u. The Anaconda company is already using gas at its copper and zinc plant at Great Falls, purchasing it from the company that supplies that city. Under the new contract referred to, it will burn the gas from the Cut Bank field at its mines at Butte and at its metallurgical plants at Anaconda. The Power Company will distribute the gas also for domestic purposes to communities wherever its franchises will permit. Cut Bank is 24 miles south of the Canadian boundary, and the new field extends from it up to the line.

This project calls for a 200-mile trunk line, about 20 in. in diameter, with branches as required. The line will run south to Wolf Creek from the Cut Bank field, thence up Prickly Pear Canyon and southwestward over the Continental Divide, branching eastward to Helena just before the Divide is reached. The main line continues south from the Divide, with another branch to Deer Lodge on the west, and on to a point east of Anaconda, where a branch will be run to the latter point and another eastward into Butte. Presumably, if desired, the gas can be readily delivered to the smelter at East Helena.

Assurance is felt that production at Cut Bank can be counted on over a long period of years. The distributing company is taking all usual precautions to insure continuous service.

Surveys are reported to have been made to determine whether or not it is desirable to extend gas trunk lines westwardly from the Montana fields into northern Idaho and thence to Spokane. The line would be over 300 miles long and would traverse wide spaces practically uninhabited, the communities en route, moreover, being

small. At Kellogg, in northern Idaho, is the only industrial plant of consequence along the route. Here the gas would have to be sold in competition with cheap, desirable, pulverized coal now being used successfully in the lead refinery at this point. The company's power is generated in hydro-electric plants. Aside from the refinery work, fuel is used only for heating. In consequence, natural gas would evidently have to be offered at an extremely low figure at Kellogg to be attractive. Whether or not this line is to be built will depend on the attractiveness of the market for the gas in Spokane and the adjacent area.

At Tacoma, Wash., there appears to be no likelihood of natural gas being available at the local smelter before its present fuel contracts expire.

Various questions confront the company that is weighing the desirability of changing to natural gas as fuel. The first is that of cost. What are the respective costs of natural gas, oil, coal, and electric power? Here must also be taken into account whether or not the introduction, or threat to introduce, gas into a district will cause a reduction in the costs of other kinds of fuel and electric power. In the same connection, the relative efficiencies of natural gas and other fuels must be considered. There are pitfalls to be avoided in comparing fuels as to cost. A company owning a source of another fuel, moreover, will naturally expect the margin in favor of gas to be large enough to warrant closing down this other operation. Another consideration is whether the use of gas in metallurgical work will make it possible to turn out a better product. Next is the question of supply. Will the gas be available in sufficient quantity and for a sufficient time? Also, is it to be brought in for any other purpose than to supply this particular company's needs?

These questions being answerable satisfactorily, still another query arises as to what the expense of switching to gas will be. The Calumet & Arizona company, which is expecting soon to make the change, estimates that to re-equip four oil-fired reverberatories for burning gas will cost about $54,000 for the piping, with duplicate valves, burners, and metering and testing special equipment.

Table I—Cost of Equipment (and Labor of Installing) Required for Burning Natural Gas at Plant of Calumet & Arizona Mining Company

Foxboro Meters, Capacity 174,000 cu.ft.	$2,000
4-in. Emco regulators	1,600
Valves, pipes and fittings	10,737
Water-jacketed burner ports	8,000
Burners	20,000
Labor	2,000
Miscellaneous	5,000
Brick	5,000
Total	$54,357

Burners and water jackets are provided by Combustion Service Company.

Table II—Cost of Natural Gas Installation El Paso Smelting Works

Main control station, building, and equipment	$4,835.25
General pipe lines serving reverberatories, roasters, anode furnaces, and copper-plant stack heater	3,415.00
Equipment for four seven-hearth roasting furnaces	1,155.42
Burners and equipment for one copper smelting reverberatory	5,456.24
Equipment and burners for two anode furnaces	2,000.00
Equipment for four direct-fired boilers	4,280.00
Equipment for laboratory and assay office	803.00
Gas testing apparatus	756.31
Total	$22,701.12

The equipment required for this change and its cost are given in Table I.

Cost of changing at any plant will depend somewhat on the layout of the plant, inasmuch as more piping may be required in one instance than in another. The amount to be spent on meters, regulators, burners, and similar equipment, however, will depend directly on the number of units to be fired with the gas.

In Table II is given the cost of equipping the El Paso Smelting Works for burning natural gas instead of oil. Table III gives the equipment required, aside from the piping. These data have been released through the courtesy of the American Smelting & Refining Company and Brent N. Rickard, manager of the El Paso plant.

At another Western smelter, gas has recently been subsituted for coal as fuel. The power plant included three 300-hp. water-tube boilers, formerly grate-fired, and one 750-hp. water-tube boiler, formerly fired with pulverized coal. Comparatively little change was found necessary in these boilers. On the three small units, the gas-burning equipment was placed in front of the position formerly occupied by the ash doors. In the large boiler, the new burners were placed below the position formerly occupied by the pulverized coal burners. In all the boilers, brick checkerwork was built within the boiler for maintaining ignition.

On the Dwight & Lloyd sintering machines, a manifold-type gas burner was installed just below the opening of the previously used "Salida stove" coke burner. At the lead-drossing kettles, a single gas burner was placed in front of the position formerly occupied by the ash doors. At the McDougall roaters, the openings from the former coal-burning grates were sealed off, and gas burners were installed at desired positions, introducing heat through the roaster shell. At the reverberatories, the gas-burning equipment was substituted for the original pulverized coal-burning equipment without any appreciable change in the furnace. All of the equipment here listed was installed by the company supplying the gas, the cost thereof being unavailable.

At the American Smelting & Refining Company's lead smelter at Murray, Utah, natural gas has been used as fuel since January, 1930. The cost of installing it, supplied through the courtesy of the company and of W. J. O'Connor, manager of the company's Utah Department, is given in Table IV.

The changes necessary in remodeling the furnaces were made as follows. The numerals refer to Table IV.

1. Boilers: Removed stokers, bricked up ash pit, put in a checkered baffle, and installed Webster burners.

2. Dross reverberatory: Bricked up bridge wall and installed five Venturi-type clay burners.

3. Wedge roasters: Cut small holes on No. 3 and No. 5 hearths and installed surface combustion burners.

4. Godfrey roasters: Removed grates, bricked up ash pit doors, and installed surface combustion burners.

5. D. & L.: Covered grate with brick and installed Venturi-type burners.

6. Cottrell stack heater: Removed stokers, bricked up ash pit doors, and installed Webster burners.

7. Baghouse stock heater: Removed grates and installed Webster burners.

8. Thaw house: Removed grates, bricked up ash pit, and installed baffles and Webster burners.

9. Lead kettles: Covered grates with brick and installed surface combustion burners.

Table III—Equipment Required for Burning Natural Gas at El Paso Smelting Works

Main Control Station

4 Meters
1 Pressure gage
1 Manometer
1 Thermostat

Wedge Roasters

1 Flow meter
1 Regulator
10 Burners
1 30-lb. pressure gage

Reverberatory Smelting Furnace

6 Burners
1 Flow meter
1 Regulator
7 30-lb. pressure gages

Anode Furnaces

2 Burners
1 Flow meter
1 Regulator

Direct-Fired Boilers

1 Regulator
2 Flow meters (high and low range)
12 Low pressure burners

Laboratory and Assay Office

2 Regulators
1 Meter
6 Gas adapters for muffle furnaces
6 Gas hot plates

Gas-Testing Apparatus

1 Calorimeter
1 Barometer
Regulators
Cabinet
Piping

10. Laboratory: Covered grates with brick and installed surface combustion burners.

11. Acid Conditioner: Removed grates and installed surface combustion burners.

In addition to the equipment mentioned in Table IV as supplied to the D. & L. machines, seven new Amarillo type muffles, costing approximately $350, have been installed and charged to repairs since gas was first installed.

Table IV—Cost of Installing Natural Gas at Murray, Utah, Plant of American Smelting & Refining Company

	Labor	Material	Other Expense	Total
Engineering and supervision, office and auto charges	$160.00	.....	$883.60	$1,043.60
Gas burners and piping	.....	$9,165.17	.....	9,165.17
Meters, including miscellaneous valves and fittings	420.60	4,242.67	.....	4,663.27
Furnace remodeling				
Boilers[1]	335.50	215.17	.....	550.67
Dross reverberatory[2]	47.80	31.43	.....	79.23
Wedge roasters[3]	92.10	48.25	.....	140.35
Godfrey roasters[4]	187.70	154.03	.....	341.73
D. & L. machines[5]	159.10	53.41	.....	212.51
Cottrell stack heater[6]	213.05	116.01	.....	329.06
Baghouse stack heater[7]	70.85	13.30	.....	84.15
Thaw house[8]	134.85	132.31	.....	267.16
Lead kettles[9]	17.05	30.80	.....	47.85
Laboratory[10]	31.20	10.79	.....	41.99
Acid conditioner[11]	10.20	.....	.....	10.20
Miscellaneous[12]	12.00	2.57	.....	14.57
Meter house	.....	900.56	.....	900.56
Total cost	$1,892.00	$15,116.47	$883.60	$17,892.07

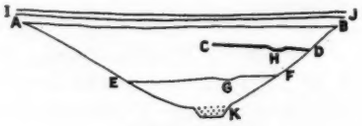
[1] For this and other references see the accompanying text.

In the minds of those who may be unfamiliar with the industrial use of gas, a question may arise as to the means taken to insure a continuous gas supply at uniform pressure, particularly in the event of a break somewhere in the pipe line. No storage is provided at the plant. Instead, the storage capacity of the line itself is used. In this line the unit pressure may be several hundred pounds, whereas the gas is used at a pressure at the burner of 4 to 8 oz. above atmosphere. Reduction from the line pressure to that at the burner is effected in two or three stages by means of a reducing valve or regulator, in order to give a uniform pressure at the burner. Such regulators are designed to allow variations amounting to only a very small percent of the pressure to be used. Under the conditions given, the capacity of a long 20-in. line, such as that now under construction in Montana, is large, as may readily be calculated. Valves are provided in the line at intervals of several miles, the length of the interval depending on the topography. Thus a break can quickly be isolated, in which case the gas in the line between the break and the point of consumption serves to meet the demand for a time sufficient to allow repairs to be made.

■ ■ ■

Construction and Operation of a Tailing Dam

CAREFUL selection and layout of the dam site, and proper distribution of tailing and drainage, are important considerations in order to avoid high maintenance cost and dam failures causing damage to the surrounding country, writes William Crocker, of Prescott, Ariz.



The accompanying illustration gives the cross-section of a tailing dam. A depression at *G* in line *EF* represents the top of the preliminary earth dam. Line *AB* indicates the top of the main dam, and the heavy line *CD* a layer of impervious tailing with a small depression at *H*. The double line *IJ* is the distributing launder, *I* being the upper part of the launder; and *K* is a ditch filled with gravel at the dam floor.

Failure to provide the artificial drain *K* may cause much trouble if the strata upon which the dam rests is not of a porous nature. Water accumulating back of the earth dam will rise and finally overflow at some depression, for instance at *D*. Excessive saturation causing continuous sloughing of tailing at that point necessitates costly repairs to prevent dam failure.

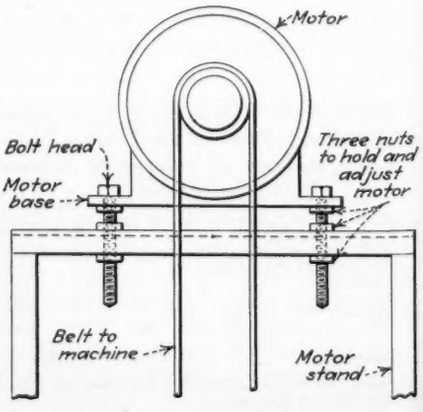
A far more dangerous condition, which, in time may weaken the entire dam structure, is faulty distribution of tailing. When the tailing is distributed through the entire length of the launder, a frequent desanding is necessary. This is done by opening some of the holes provided in the upper part of the launder. As the coarser portion of the tailing is discharged at these points, an impervious strata or dam is gradually formed, along that section, as illustrated by the heavy line *CD*; and fines are distributed at the lower part of the launder. As the height of the dam increases, water is impounded back of the deposited strata. In time the water overflows at point *H*, causing sloughing that gradually undermines and weakens the structure of the dam, unless the necessary repairs are immediately made and a proper drainage system is provided. To avoid this occurrence the tailing should be discharged from but one outlet of the distributing launder.

Ditches dug into the sides of the dam containing the graded drain pipes or boxes may also be the cause of failures. If the hollow space around the drains is not filled with earth, but is allowed to fill up with tailing, saturation will again cause steady sloughing and caving. This results in cracks which in time may extend to the water in the dam, often with disastrous results.

■ ■

Adjustable Belt Tightener for Motor Stand

WHEN a motor is mounted on an upright stand, tightening of the drive belt is difficult owing to the motor base being non-adjustable in this position. To avoid the time-wasting procedure, generally employed, of dismounting the motor and then placing wooden segments under the motor base to raise the motor and thus effect a tightening of the belt, the method shown in the accompanying self-explanatory sketch was devised. The motor, detached from its base, rests on four long tension bolts—in this instance, $\frac{5}{8}$x8 in.—each provided with three nuts to fasten the bolts rigidly to the motor legs and to adjust, level, and bolt the motor to the upright motor stand. To tighten the belt, the nuts below the motor stand are loosened and those in the middle or above the stand are tightened until the belt is rigid and central. The use of washers is recommended if the diameter of the motor feet holes exceeds that of the bolts.



WEIR DISCHARGE CHART

THIS chart is designed to show the quantity of water flowing over any one of three standard types of weir, when the weir dimensions and the head of water are known. It is based on the familiar formulas:

90-deg. V-Notch Weir, $Q = 2.53H^{5/2}$

Rectangular Notch Weir, $Q = 3.33\ (B - 0.2H)H^{3/2}$

Cippoletti Weir, $Q = 3.367BH^{3/2}$

Q being the quantity flowing in cubic feet per second; B and H the width and head, respectively, in feet.

On this chart the discharge from a 90-deg. Notch is shown on the same scale as, and directly opposite, the head. For the Rectangular and Cippoletti weirs, a straight-edge laid across the chart connecting the width and head on their respective scales will intersect the *Quantity* scale at a point showing the discharge under the given conditions.

EXAMPLE: What quantity of water is flowing over a Cippoletti weir when the bottom width is 30 in. and the head 7½ in.?

PROCEDURE: Align 30 on the *Width* scale with 7½ on the *Head for a Cippoletti Weir* scale, reading at the intersection on the *Quantity* scale 250 cubic feet per minute.

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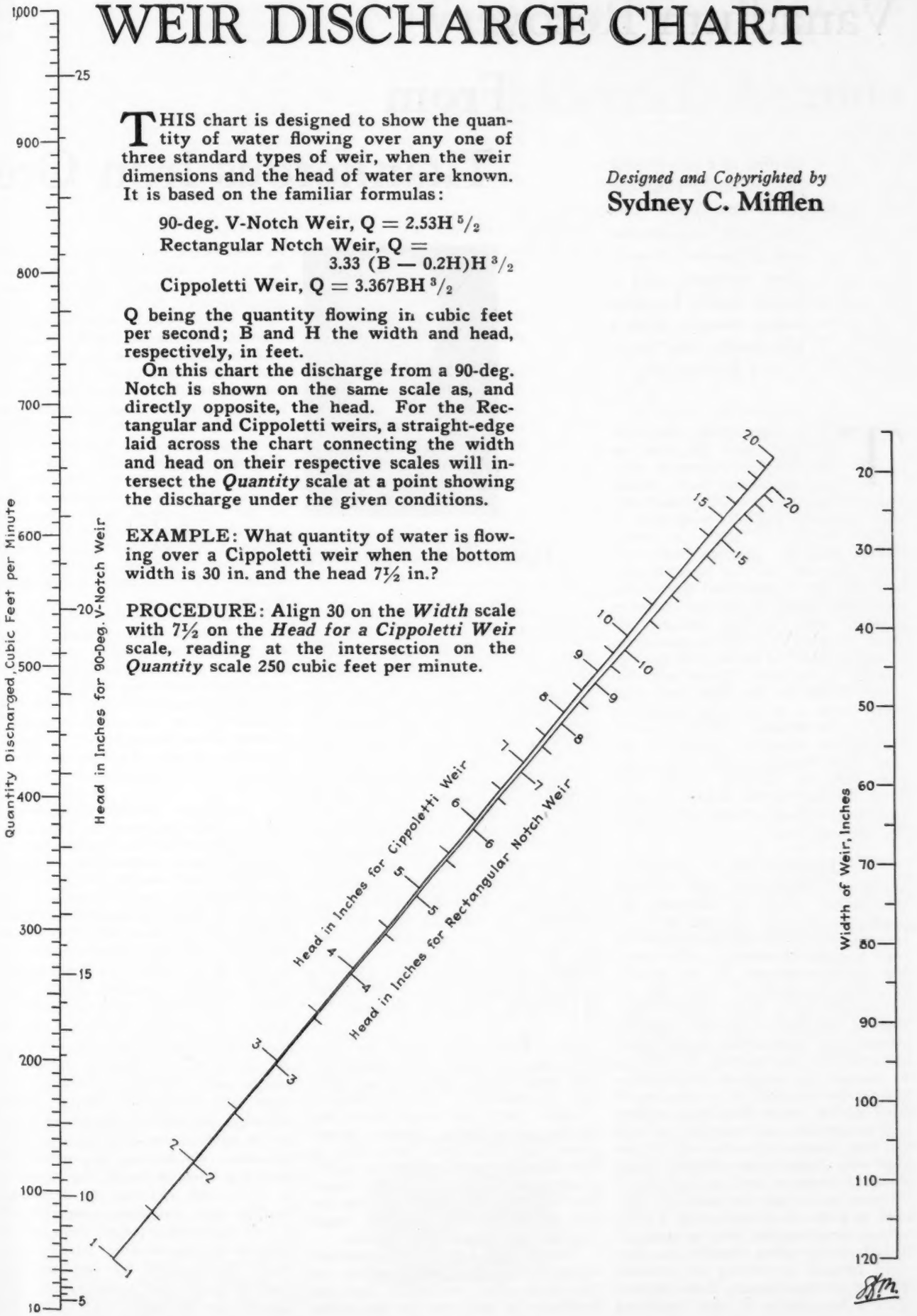
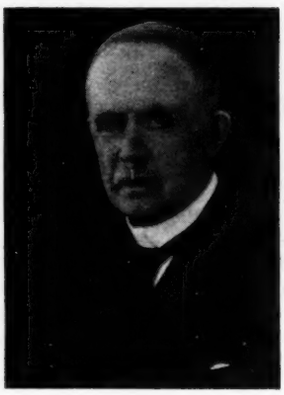
Sydney C. Mifflen



Vanadium Recovery From Titaniferous Iron Ore

Outline of a wet process for extracting vanadium from titaniferous iron ores and concentrates, with production of vanadium pentoxide and a residue which, when melted directly, yields a high-quality steel and a rich titanium slag



Björn P. F. Kjellberg

THAT titaniferous iron ores present many obstacles to metallurgical treatment is a well-established fact. Reduction of these ores is accomplished only with difficulty, and the production of highly titaniferous slags is costly. Actual smelting practice with calcined ore and raw or sintered concentrates has demonstrated that a slag containing about 20 per cent titanium dioxide, with varying amounts of silica, alumina, lime, and magnesia, has a melting point of about 1,500 deg. C., whereas a slag with 10 per cent titanium dioxide or less does not differ much from a normal slag containing little or no titanium. Efforts to maintain a low titanium content in the slag, when treating highly titaniferous iron ores, do, however, result in a large increase in the amount of slag produced, with an adverse effect upon the smelting cost.

Judging from the results obtained in experiments with calcined concentrates from the Kramsta deposits, in Sweden, the difficulties in treating titaniferous iron ores do not always manifest themselves. After treating the concentrates by the process described in *E.&M.J.* Vol. 123, p. 521—calcining a finely ground mixture of fluorspar (3.5 per cent by weight) and concentrate containing 64 per cent iron, and leaching the mixture to remove the vanadium compounds—the residue obtained is an iron ore of high quality, nearly free from sulphur and phosphorus, and carrying up to 6 per cent titanium dioxide with 61 per cent iron. Heated after addition of fine charcoal, molasses, and tar, in ratio of 77 parts of residue, 14 parts of charcoal, 6 parts of molasses, and 3 parts of tar, firm briquets may be obtained. Fused in a graphite crucible in a gas-fired furnace, permitting the crucible to cool in the furnace, these briquets gave a fine quality of steel, analyzing 1.28 per cent carbon, 0.46 silicon, 0.74 titanium, and 0.1 per cent vanadium, with a slag containing 7.6 per cent iron and 43.74 per cent titanium dioxide. This amount of iron in the slag may seem high, but this is really not the fact, as the ratio of slag to metal is only 15.6 : 84.4, giving a slag loss of only 1.4 per cent of the iron contained in the concentrate. This fortunate circumstance is probably caused by the fact that the ilmenite and the magnetite in the concentrate occur in an intimate mixture. When previously decomposed by intense calcination, the titanium oxide of this aggregate is slagged more readily than if smelted without such treatment. At the same time, reduction of the iron oxide is facilitated. The slag is exceptionally high in titanium dioxide and should furnish a good raw material for the production of titaniferous products or metallic titanium.

From these results the inference may be made that titaniferous iron ores, under conditions as given, may be utilized for direct production of steel. Such steel should be of high quality, according to modern investigators (see *Stahl und Eisen,* 1928, pp. 853: "Beitrage zur Kentniss der niederprozentigen Legierungen des Eisens mit Titan"). Although small, the content of vanadium in the steel should also tend to improve its qualities.

Titaniferous iron ores containing vanadium are particularly suited for this direct steel process, as they may profitably be subjected to the preliminary calcining and leaching procedure. In regard to the details of this method the following change has been found advantageous. In the article from *E.&M.J.*, previously referred to, an aqueous solution of sulphur dioxide was recommended for leaching, principally on account of the low price of this solvent. This procedure does, however, involve some objectionable features, partly on account of the difficulties encountered in washing out the sulphur from the residue and partly because of the cost of removing the sulphur dioxide from the solution prior to the precipitation with lime. As dilute hydrochloric acid is also available at a low price, being a byproduct of certain chemical processes, this solvent has been found more practicable.

To the solution obtained by cold leaching of the calcine sufficient aqueous solution of sulphur dioxide is added to permit precipitation of the vanadium compounds with lime. The precipitate, analyzing about 40 per cent vanadium when dried, carries a small amount of sulphur, which may be expelled by calcining prior to the manufacture of ferrovanadium.

Pure vanadium pentoxide, which of late has found extensive use as a catalyst in the manufacture of sulphuric acid and other chemical processes, may also be produced from the precipitate. For this purpose it is dried and fused in a nickel crucible with about one and a half of its weight of soda, and the fused product is leached with water. To the solution, which contains vanadate, silicate, aluminate, phosphate, and sulphate of sodium, is added a small amount of vanadium pentoxide, whereby the minute quantity of silica is completely precipitated. Alumina is then precipitated with free carbon dioxide. After filtration, ammonium chloride is added to the solution, precipitating ammonium vanadate. By heating this precipitate to a few hundred deg. C. the ammonia is driven off and may be recovered, leaving pure vanadium pentoxide, of a yellowish-brown color. Ammonia in solution is recovered by heating with lime. Consumption of reagents, and cost of labor and equipment in this process are not high.

Crushing and Flotation at Morenci, Arizona

George J. Young
Associate Editor

IN THIS AGE of progress, men and mines often outlast mill equipment, an observation well exemplified at Morenci, Ariz. There, the concentrator of the Phelps Dodge Corporation has been continuously in charge of Arthur Crowfoot since 1915, but before that date several fundamental changes were made and since 1915 other alterations and improvements have been incorporated. In fact, that concentrator exemplifies the evolution of milling equipment and methods during the last quarter of a century. The management of the Morenci branch of the Phelps Dodge Corporation has always had the courage to scrap machinery and to improve methods whenever better recoveries or more efficient operation could be demonstrated. I have had the pleasure of visiting the plant a number of times, and upon each visit I found a program of change either in the midst or just about finished. This was equally true when I made a short visit in April, 1930. No. 6 concentrator had just been revamped and was beginning a new campaign, to continue until better combinations of equipment and methods seem advantageous.

Coarse and Fine Crushing

The coarse- and fine-crushing circuits have been simplified principally by the adoption of Symons cone crushers for the intermediate stage. A coarse-ore bin of 1,200 tons' capacity receives the skip discharge. The ore then passes over a bar grizzly (38 in. by 52 in. wide, 4 in. between bars), oversize going to an Allis-Chalmers 36x48-in. jaw crusher (maximum opening, 8 in.) and crusher product and grizzly undersize being received upon a conveyor (No. 1, 32 in. x 190 ft. c. to c.) that discharges upon a Traylor vibrating screen (¾-in. square openings), oversize and fines being received separately in a three-compartment surge bin. Oversize is taken by two 36-in. apron feeders (one a spare) and discharged into two Symons 7-ft. cone crushers set for a maximum of ½ in. One of the cone crushers is a standby or spare. A third apron feeder removes the undersize, the product of both crushers, and the undersize is taken by a 28-in. belt conveyor (150 ft. c. to c.) to the ten fine-ore bins, which have an aggregate storage capacity of 5,770 tons.

Thirty drum feeders (S.A. automatic rotary feeder) discharge upon a conveyor system which delivers the fine ore to four primary Hum-mer screens (three-mesh openings, 42 deg. slope). Oversize passes to four sets of 56x24-in. rolls, the product of which is taken by belts and bucket elevators to eight secondary Hum-mer screens operated in closed circuit with the rolls.

Screen undersize, practically all through 6 mesh, is concentrated upon 40 Deister Plat-O roughing tables, which make a finished concentrate and a reject which enters the flotation and fine-grinding departments of the mill.

The table reject is received into six dewatering, 6½x21-ft. Dorr classifiers, which discharge into six primary ball mills (three Allis-Chalmers 7x12 ft. and three Vulcan Iron Works 8½x12 ft.) in closed circuit with Dorr classifiers (6 ft. 8 in. by 26½ ft.), which also receive the overflow from the dewatering classifiers. Overflow is sent to eighteen Forrester type roughing cells 18 ft. long by 48 in. wide, which deliver flotation concentrate to a primary Forrester cleaner cell 24 ft. long by 48 in. wide, the finished concentrate going to thickeners and Oliver filters and the middling joining the tailing from the primary roughers.

Primary flotation tailing and primary cleaner middling are received in five 18-ft. Dorr bowl classifiers, which discharge sand into five secondary grinding mills (five 6½x12-ft. Marcy type), which are in closed circuit with the bowl classifiers. The final grind is 1½ per cent on 65 mesh or 71 to 72 per cent past 200 mesh.

Overflow from the bowl classifiers passes to the secondary flotation circuit, where it is divided among thirteen cells, all of the Forrester type and of different sizes. Secondary rougher concentrates go to a Forrester cleaner cell (24 ft. long by 43 in. wide), the cleaned concentrate passing to a second cleaner of the same size and type, which makes a finished concentrate for the thickeners and the filters. Middlings from both cleaner cells are pumped by two 6-in. Krogh pumps to the rake compartments of the bowl classifiers. Secondary rougher tailing goes to eight MacIntosh cells (five 20 ft. long, three 10 ft. long—all with 9-in. rotors), the rougher concentrate being returned to the bowl classifiers by the Krogh pumps and the tailing going to a large scavenger cell of the Forrester type, circular, 120½-ft. circle by 43 in. wide. Rougher concentrate from the scavenger is returned by the pump to the bowl classifiers, and final tailing passes to five Dorr thickeners, one 200 ft. diameter, one 130-ft. diameter and one 100 ft. diameter, and two 60 ft. square. Reclaimed water is pumped back by one 14x12-in. and two 12x16-in. Aldrich triplex pumps and one 10-in. Allis-Chalmers centrifugal pump.

Flotation concentrate is sent to two 30-ft. thickeners, the overflow being received by a 30-ft. thickener; this overflow then goes to a 60-ft. thickener and thence to the pumps for return. All spigot products go to Oliver filters (two 11½x12 ft. and one 14x14 ft.; one is a standby). Oliver filter discharge is delivered by conveyors to cars for shipment to the Clifton smelter. Table concentrate is delivered to two dewatering classifiers, the overflow passing to one of the 30-ft. thickeners and the concentrate to a vacuum classifier, which still further dewaters and discharges to the concentrate conveyor system which discharges directly into railroad cars for the smelter.

The 36x48-in. jaw crusher is driven by a Tex-rope drive from a 150-hp. induction motor. Symons cone crushers are driven by 240-hp. synchronous motors with Tex-rope drives. Two 75-hp. motors operate each set of 56x24-in. rolls. The two bucket elevators receiving the roll discharge and delivering to the secondary Hum-mer screens are driven by 50-hp. induction motors. Deister tables are each provided with 1-hp. back-geared motors. The 7x12-ft. ball mills are driven by 250-hp. synchronous motors and the 8½x12-ft. ball mills (18 r.p.m.) by 300-hp. synchronous motors. The Marcy ball mills are driven at 19 r.p.m. by 150-hp. induction motors. Total power is 13.62 kw.-hr. per ton, and line losses aggregate 0.49 kw.-hr. per ton, making an over-all power input of 14.11 kw.-hr.

Analyses of Feed, Concentrate, and Tailing

	In Per Cent		
	Feed	Concentrate	Tailing
Total Copper	1.82	18.73	0.33
Sulphide copper	1.63	18.30	0.16
Iron	3.61	26.80	1.60
Sulphur	2.90	33.8	0.20
"Insoluble"	.....	17.90	.....
Silica	66.2	14.3	70.8
Alumina	15.7	3.5	16.8
Lime	0.8	0.5	0.8

With the business depression, opera-

Metallurgical Data, 1925 and 1930

	April 1925	April, 1930
Per cent copper in feed:		
Total	2.20	1.82
Sulphide	2.04	1.63
Acid-soluble	0.16	0.19
Per cent copper recovered:		
Total	86.8	86.0
Sulphide	91.1	93.0
Acid-soluble	.....	20.3
By tables	37	19
By flotation	49	67
Acid-soluble by tables	.....	8.5
Acid-soluble by flotation	.....	12.9
Per cent total iron recovered	.....	61.5
Concentration ratio:		
Over-all	11.9:1	11.2:1
By tables	.....	37:1
By flotation	.....	15.6:1
Per cent copper in tailing:		
Total	0.32	0.28
Acid-soluble	0.12	0.15
Sulphide	0.20	0.13
Primary grinding, per cent:		
On 48 mesh	.....	8
Minus 200 mesh	.....	51
Secondary grinding, per cent:		
On 65 mesh	6	1.2
Minus 200 mesh	68	70
Reagents, pound per ton ore:		
Xanthate	0.113	0.101
Pine oil	0.061	0.092
Lime	.....	4.336
Water, gallons per tone ore:		
Total	1,572	1,558
Fresh	330	283
Power, kw.-hr. per ton ore	14.1	13.6
Labor, tons ore per man-shift	22.7	30.1

tions have been curtailed considerably at Morenci, as elsewhere. In April, 1930, the daily tonnage averaged 5,014.

In 1925, Arthur Crowfoot (*E.&M.J.*, Vol. 120, p. 884) described the concentrator, on the basis of 4,500 tons per day, and also the metallurgical results at that time. Comparison of the April, 1925, data with those of April, 1930, may be made in the accompanying table.

Comparison of the 1925 and 1930 data shows the recent ore is somewhat lower-grade, though with higher acid-soluble content. Total recovery is slightly lower and sulphide copper recovery slightly higher. Grinding is finer and ratio of concentration somewhat lower. Acid-soluble copper in tailing is higher, but sulphide copper is lower. Power consumption is about the same, but less water and a higher tonnage per man-shift have been attained.

Metallurgically, the work of 1925 was excellent, for it compares very favorably with the work now being done. The ore is highly abrasive and difficult to reduce. The finer grinding is an advantage upon the lower-grade ore, but as the sulphide content of the tailing approaches 0.10 per cent copper it would appear that the limit of fine grinding has been practically attained. In the present mill, the principal advantages are in the coarse- and fine-crushing divisions and in the simplification of the equipment and its arrangement in the mill as a whole. Economy in water used and in labor required has been attained, and this is undoubtedly reflected in the costs of operation.

Morenci milling practice differs from that in other Arizona copper-concentrating plants. A steep hillside location enables advantage to be taken of a terraced arrangement and gravity flow. As a consequence only one pair of bucket elevators (roll circuit) is necessary in the coarse and fine crushing; in the fine grinding and flotation, apart from the elevation at classifiers, the only return by pumps is the combined middlings from the secondary cleaner and cleaner flotation cells and the rougher concentrates from the tertiary rougher cells and scavenger cells. Likewise, the retrieved water is pumped back. The retention of table concentration, the interposition of flotation between the two stages of fine grinding, and the two stages of closed-circuit grinding in sequence are characteristic of the plant. Whether the simplification that could be attained by the elimination of the rougher tables would be an advantage is debatable. The tables give a granular concentrate at low cost, easily handled and exceedingly advantageous to the smelter because a band of copper-bearing siliceous material can be cut out at practically no cost, to serve as furnace flux. The division of the flotation separation into two sequential parts separated by secondary grinding represents a complication more apparent than actual.

All of the copper concentrators use two stages of fine grinding, but flotation separation usually follows the fine grinding. The principal advantage of the Morenci arrangement is the greater time given to pulp conditioning. It is evident that primary flotation, followed by secondary grinding, is in fact a thorough conditioning circuit, to be followed by secondary or final flotation. Practically all of the concentrating mills resort to scavenger cells in series of two or more.

Efficient Motor Bearing Puller

REMOVING and replacing press-fitted motor bearings from the end bells consumes much time when not performed with proper tools and care. The method, often used on smaller motors, of hammering the bearings in and out, is unsatisfactory, because of the danger of deformation and injury to the machined babbitt bore. A puller, recently developed at the New Cornelia mines of Calumet & Arizona, at Ajo, Ariz., with which motor bearings can be removed and replaced within a few minutes, has satisfactorily overcome this difficulty. As illustrated in Fig. 1 of the accompanying sketch, the puller consists of a cylindrical yoke, a tension bolt with its head containing a small ball-thrust bearing to ease operations, and a machined end washer. All parts are made of mild steel.

When removing a bearing from the detached motor end bell, the end washer is first placed to cover the end of the bearing, and then screwed to the tension bolt attached to the yoke resting upon the opposite side of the end bell. By turning the bolt, the exerted pressure gradually removes the bearing from the end bell without difficulty. The replacing of a bearing is effected in a similar manner, by again using the end washer and tension bolt, but eliminating the yoke. For removing bearings with end shoulders, the contrivance illustrated in Fig. 2 is employed. It consists of a conical, hollow, threaded core, over which the three fang-like segments are placed and held together by a small cylindrical casing. The core, when raised by the tension bolt, presses the steel segments into the soft babbitt, and additional pressure then detaches the bearing from the end bell.

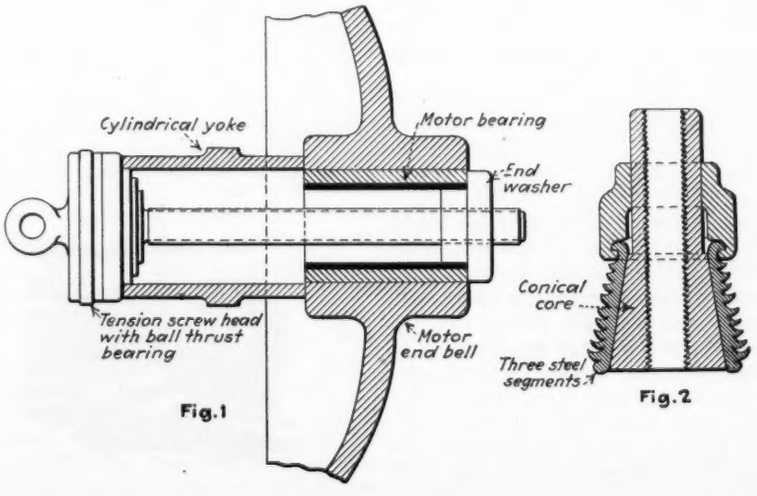


Fig. 1

Fig. 2

Amalgamation Practice in Canada

IN VIEW of the revival of interest in gold mining, information dealing with practices and costs in the development of gold properties is apropos. Milling practice at a small gold property in the prospect stage is described. With a small outlay for plant and equipment, development was carried on for about twenty months on the proceeds of mill operation, with little additional expenditure. This paper is an abstract from one of a series being issued by the U. S. Bureau of Mines (Information Circular 6433). The author is mill foreman at the plant described, and one of the consulting engineers to the Bureau.

Ronald A. Vary

PORCUPINE United Gold Mines is a reorganization of claims that adjoin the Hollinger and McIntyre mines on their north boundary, at Timmins, Ont. The ore consists of quartz, with fine stringers of mineralized basaltic schist, or of banded quartz schist, or of stringers of quartz in schist, accompanied by pyrite and often containing visible gold. The gangue rock is basaltic schist.

The mill is an amalgamation plant of 25 tons' daily capacity, installed as a pilot mill to help defray costs of development and to treat high-grade ore, with a cyanide plant the final objective as soon as mining developments warrant one. About 75 per cent of the gold in the ore is free milling and most of it fairly coarse.

Hoisting and crushing are done on day shift only. Milling ore is trammed to the shaft and hoisted to the surface in 1-ton cars. The crushing plant is in the shafthouse, and the ore is dumped, as hoisted, on a grizzly of 40-lb. rails spaced 5 in. apart, which covers the 15-ton crusher ore bin. Large chunks are broken up and put through the grizzly by the shaft deck man. The crude ore is fed to a 7x10-ft. Allis-Chalmers jaw crusher, driven by a 15-hp. motor. The crusher breaks the ore to 1x1½ in. and discharges it to a 12-in. conveyor belt, feeding a 10x18-in. Allis-Chalmers rolls. The product, 75 per cent of which is less than ½-in. mesh, falls on a 12-in. conveyor belt, traveling 100 ft. per minute, and is conveyed to the mill, 75 ft. from the shafthouse. A 10-hp. motor belted to a countershaft drives the rolls and the roll-feeder conveyor. Both rolls are operated at 90 r.p.m. Occasional burning off of high ridges on the shells is required to keep them in good working condition.

The crusher plant is operated by one man, who does the necessary repair work and helps in the mill when he is not tending the crusher. The 12-in. conveyor discharges into the boot of an elevator with 10-in. buckets spaced 18 in. apart, 33-ft. centers, speed 250 ft. per minute, which delivers the ore to the mill bin. This bin, 12x12x10 ft., is constructed of 3-in. planks. It has a capacity of about 50 tons.

Grinding is at present done in a 4½-ft. by 16-in. Hardinge mill, carrying a ball load of about 4,000 lb. It is operated at 31 r.p.m. and grinds an average of 25 tons of ore per 24 hours to 65 per cent through 200 mesh, with a circulating load of 125 per cent. The discharge contains 32 to 36 per cent solids. Four-inch forged-steel balls are used, the wear being about 1½ lb. per ton of ore ground. The standard, wedge-bar, manganese-steel liners in the mill last twelve to fifteen months. The ball mill is in closed circuit with two amalgamation plates and a 4x14-ft. duplex Dorr classifier, inclined 2 in. to 1 ft. and making 26 strokes per minute. In operation, the classifier rake product is returned by gravity to the ball-mill feeder scoop, where water is added for regulation of the moisture content of the ball-mill charge. Overflow from the classifier is sampled hourly by hand, by taking dip samples from its overflow launder. The ball mill is belt-driven from a line shaft which is belted to a 50-hp. motor. Line shaft and motor supply power for all mill machinery, including the 12-in. conveyor belt from the crusher plant and the elevator. The Dorr classifier is driven by a 5-hp., three-phase, 550-volt motor.

The ball-mill discharge falls into a distributing box, where water is added and the flow distributed to two 4x8-ft. copper amalgamation plates, ⅛ in. thick and with a slope of 1⅝ in. to 1 ft. Much coarse gold is trapped by the distributing box. This box is cleaned out once a week and its contents are run through an amalgamation barrel. Table frames supporting the amalgamation plates are of 2x4-in. lumber, with cross pieces, placed on edge, spaced 6 in. apart. The table decks are made of 1-in. shiplap, on which the copper plates are screwed. Deck slope can be changed to suit conditions by placing wedges between the deck and the table frame. The plates are not silvered, and the copper has to be treated with a weak cyanide solution before the mercury will amalgamate. Little trouble has been experienced by copper showing on the plates.

Mercury is shaken on the top half of the plates; none is added elsewhere. The plates are ordinarily dressed every three hours, but oftener if the ore is rich, depending on the judgment of the operator. The method employed in cleaning a plate is to bypass the feed to the other plate, clean off ore particles, then brush the plate well with a stiff whisk broom, working loose amalgam to the top of the plate. This loosened amalgam is removed. If this leaves the plate too dry, mercury is shaken on and rubbed in well. The plate is then brushed horizontally, working from the center to the sides and starting at the bottom and working to the top of the plate. Amalgam or loose mercury adhering to the sides of the plate is then brushed to the top or removed if the amount is appreciable.

On the morning shift the plates are given an extra brushing, and mercury is added to loosen the amalgam. Then the amalgam is stripped off with a piece of rubber conveyor belting, the stripping being done horizontally to the flow on the plate; the amalgam is lifted, and the plates are re-dressed in the usual manner. Care is taken that the plates are not stripped too clean.

Very little crystallization of the copper takes place, and the plates are rubbed occasionally with a weak cyanide solution, which removes any tarnish or stains. Sufficient water is used to maintain an even flow of pulp over the plates, and when the ball mill discharges too much coarse material, the feed is cut off for a short period. Forty per cent of the total gold recovery is made on the amalgamation plates.

On the lower end of each table, below the amalgamation plate, a sheet of ⅛-in. iron plate, 42x48 in., is fastened. A blanket of No. 6 silence cloth is laid on this plate and secured by a flat iron bar, ⅛-in. thick and 2 in. wide, laid on top of the blanket. The bar is held by notches cut in the table frame. Pulp from the amalgamation plates passes over the blankets, on which pyrite, fine gold, and mercury from the plates are caught. The blankets are changed and washed in a tub after each dressing of the plates, the concentrate being sent to the amalgamation barrel for treatment. Both plate and blanket tailings drop to amalgam traps at the end of each table, and are elevated therefrom by an 8-in. bucket elevator, which returns them to the Dorr classifier. This elevator has a deep sump, which is a good trap, and

which is cleaned out at regular intervals. Amalgamation takes place in the whole circuit. Elevator discharge launders, classifier, and other launders all collect rich sand and amalgam. These are cleaned out periodically and treated in the amalgamation barrel. Thirty-five per cent of the gold is recovered by barrel treatment.

The rake product from the Dorr classifier is returned to the ball mill, and the overflow runs by gravity to a

Costs Per Ton of Ore Treated

	Labor	Power	Supplies	Total
Crushing.....	$0.214	$0.135	$0.035	$0.384
Grinding.....	0.429	0.180	0.162	0.771
Classifying, screening, conveying, refining.....	0.429	0.090	0.107	0.626
Miscellaneous....	.....	.....	0.070	0.070
Totals.....	$1.071	$0.405	$0.374	$1.851

Supplies

1. Steel and iron:	
Ball consumption, pounds per ton ore milled	1.50
Liner consumption, pounds per ton ore milled	0.48
2. Mercury, ounces per ton ore milled.....	0.05
3. Power, kilowatt-hours per ton ore milled...	40.00

Gibson impact amalgamator, attached to a James sand-concentrating table. The amalgamator catches float mercury and fine gold that has escaped the amalgamation plates, blankets, and traps. Once a week the amalgamator is opened and washed, and its plates are scraped. The James table is operated at 250 r.p.m. with a ¾-in. stroke. Table concentrate, averaging $40 per ton, is dewatered and sent for cyanide treatment to an affiliated company. Table tailing is elevated by an 8-in. bucket elevator to the tailing dump. Both table concentrate and table tailing are sampled hourly by hand, by taking dip samples from the launders. Assays are as follows: Average feed to amalgamation plant, $11 per ton; table feed (amalgamation tailing), $2.80 per ton; table tailing, $1.80 per ton; table concentrate, $40 per ton.

Concentrates or sands from the blankets, traps, and launders are ground for ten hours in a cast-iron amalgamation barrel, 16-in. in diameter and 36-in. long, revolving at 22 r.p.m., using worn balls from the ball mill as grinding media. Then about 250 oz. mercury and 3 lb. slacked lime are added to the charge, and it is again ground from five to eight hours. The barrel is washed out into a box, the iron balls are carefully cleaned by hand, and the residue is run over a small amalgamation plate to the mill circuit. Both the mercury and amalgam are collected, washed, and cleaned with hot water, then squeezed by hand through fine sheeting, to eliminate excess mercury, retaining the amalgam in the form of a ball.

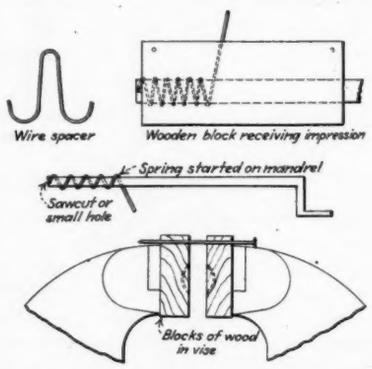
The amalgam is retorted outside the mill over a wood fire at regular intervals, using a cast-iron retort with a capacity of 1,000 oz. Sponge-gold yield is 35 to 40 per cent of the weight of the amalgam retorted, and the mercury loss is small. The sponge gold is melted in an oil-burning furnace at the affiliated company's refinery. Soda, borax, and manganese dioxide are used for flux, and the molds are coated with lampblack. The bullion is sampled by drilling small holes in opposite ends of the bar at top and bottom. Of this bullion the average grade is: Gold, 770 fine; silver, 120 to 140 fine.

Two amalgamators working eight hours each constitute the crew for the mill. On the day shift the mill is operated by a mill foreman who takes care of cleaning the amalgam, retorting, and melting.

■ ■

Handmade Coil Springs

LACKING a lathe, small coil springs can be made in a drill press or a bench vise as follows, according to Charles Labbe: A rod or mandrel, somewhat smaller than the diameter of the spring to be made and containing a small hole to accommodate the end



of the steel wire, is attached securely to the drill chuck. Then the drill spindle is revolved once or twice and a spacer, made of soft wire corresponding in thickness to the pitch of the spring coils and shaped as shown in the accompanying sketch, is held in the right hand and placed between the two starter coils. Next, the drill press is started at slow speed, and, with the left hand, the steel wire is fed under tension until the desired length of spring is reached—a procedure requiring only a few seconds. In a similar way springs can be made with the aid of a breast drill attached to a bench vise.

When no drill of any type is available, coil springs can be made in a bench vise by utilizing two blocks of soft wood held together by two guide pins, a mandrel containing a crank end and a slot or hole, and a sample spring. Guide channels or impressions are made in the two wooden blocks to insure the correct pitch and winding of the spring coils by pacing the sample spring, mounted on a rod, between the two blocks and tightening the jaws of the bench vise. Next, the end of the steel wire is placed in the slotted end or hole of the mandrel, and one or two starter coils are made by winding the wire around the mandrel. Then the mandrel and coils are carefully placed between and into the guide channels of the blocks; the vise is tightend and th crank end of the mandrel slowly turned, the wire being guided to follow the impressions in the wood, as shown at the left.

After a number of turns, as shown, have been made, the vise is loosened and the advanced mandrel and spring are returned past their original position, to lengthen and deepen the impressions in the wood and facilitate the winding of the wire around the entire length of the mandrel.

To prevent an uncoiling and tangling of the wire, suspend the coil on a nail near the bench vise and pass the end of the wire between two heavy blocks of wood, which act as a brake and feed the wire to the mandrel under tension. The same procedure can be employed for making close-coiled springs, except that no guide impressions are first necessary, as the wire coiling around the mandrel forces its own impressions into the wood.

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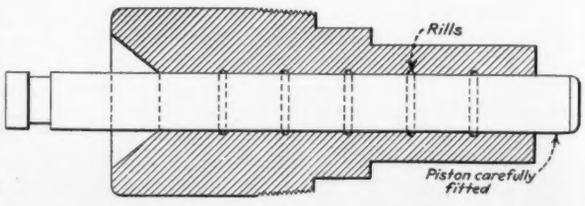
Remodeled Piston Casings

AT THE compressor house of the Moctezuma Copper Company, Pilares, Sonora, Mexico, leaky fuel injection pump stuffing boxes on the Diesel engines driving the large air compressors were a source of trouble and expense. Moreover, the frequent repacking of the stuffing boxes necessitating the shutting down of the Diesel unit, resulted in decreased compressed air output. To remedy and overcome these difficulties once and for all, the stuffing-box-type of piston casings were scrapped and replaced with others made locally of brass, containing a carefully fitted bore with five shallow rills to seal and lubricate the reciprocating steel pump piston, as shown in the accompanying sketch.



Determination of Cadmium, Lead, and Iron in High-Grade Zinc

B. H. Strom
Assistant Editor

PRODUCTION of high-grade zinc has necessitated the introduction of analytical methods of sufficient accuracy to allow the determination of impurities such as cadmium, lead, and iron in amounts down to 0.001 per cent. The following methods, used in the laboratories of Anaconda Copper Mining Company, are meeting these requirements, offering the advantages of easy and rapid manipulation and permitting a high daily output. In daily control work and for shipments, lead and cadmium are determined on the same sample. In addition, two other methods may be used for the determination of lead only.

In the first method 100 grams of zinc shot or drillings is placed in a 2,000-c.c. beaker, moistened with 100 c.c. water, and dissolved in 350 to 400 c.c. concentrated nitric acid. If the sample is slow in dissolving, the beaker may be heated gently. After cooling the solution with a piece of ice, about 2 cu.in., or with 50 c.c. of cold water, concentrated ammonia is added while the solution is stirred constantly, until the precipitated zinc hydroxide is dissolved; an excess of 200 c.c. is then added. While the solution is still hot, yellow ammonium sulphide (1:10) is added slowly, stirring the solution vigorously with a rubber-tipped glass rod. During the precipitation the temperature of the solution should be at least 80 deg. C. About 25 c.c. ammonium polysulphide is sufficient if the amount of impurities is not very high. An appreciable amount of zinc must be carried down to insure complete precipitation of cadmium and lead. The correct amount may easily be judged by watching the color of the precipitate.

The precipitate is allowed to settle, filtered on a fluted funnel through an 18½-cm. paper of medium texture, and washed once with hot water after having rinsed the sides of the beaker with hot water and a small amount of ammonia. A hole is punched through the filter paper and the precipitate is washed down into the empty beaker with warm hydrochloric acid, containing 350 c.c. concentrated HCl per liter, taking care that nothing is left on the paper. The sides of the beaker are washed with acid of the same strength; 50 c.c. nitric acid, and 20 c.c. sulphuric acid are added, and the solution is taken to dryness on a hot plate covered with a light pad of asbestos. After cooling, 5 c.c. sulphuric acid and 40 to 50 c.c. water are added, the beaker is heated to dissolve the soluble sulphates, and cooled in a cooling tray. The insoluble lead sulphate is filtered on a small paper of fine texture, washed five times with cold water, dissolved in hot saturated solution of ammonium acetate, and titrated with ammonium molybdate.

The filtrate from the last operation, containing the cadmium and a small amount of zinc, according to the excess of polysulphide used in the precipitation, is diluted to about 125 c.c. With the amount of sulphuric acid present, 5 c.c., cadmium sulphide will precipitate completely, and most of the zinc remains in solution. A separation of the two metals is therefore possible by one or more precipitations with hydrogen sulphide.

A rapid stream of hydrogen sulphide is passed through the hot solution. If a precipitate of cadmium sulphide has appeared after five minutes, 50 c.c. of water is added and the gassing is continued for five minutes more. If the preciptation does not start in five minutes, addition of water, 25 c.c. at the time, or of ammonia, drop by drop, will bring it about. The sulphide is filtered on a heavy, No. 3 Whatman paper or a No. 100, 12½-cm. Munktell and washed four times with hot water, or preferably with 3 per cent sulphuric acid, saturated with hydrogen sulphide.

A few drops of ammonia added to the filtrate will show if all cadmium has been precipitated, and will also give an indication of the amount of zinc present.

The original beaker is placed under the funnel and the precipitate is dissolved through the paper with hot, dilute hydrochloric acid (one part of acid and three parts of water), washing the front of the paper twice, followed by two washings of the back, and finishing with two more washings of the front. Care must be taken to keep the volume of wash water down, to save time in the subsequent fuming. After dissolving the sulphide, 5 c.c. sulphuric acid is added, and the beaker is brought to fumes on a hot plate, covered with a light pad of asbestos.

Precipitation with hydrogen sulphide is repeated until the filtrate contains no appreciable amount of zinc. After the final precipitation the solution is fumed to complete dryness, and the sulphate dissolved in 10 c.c. of water. A drop of phenolphthalein solution is added, and the solution is made basic with a strong solution of sodium hydroxide, carefully avoiding excess. Two drops of a saturated solution of sodium or potassium cyanide are added, and the solution is diluted to 200 c.c. and electrolyzed for one hour with a current of 0.5 to 0.6 amp., using a platinum-gauze cathode and a platinum-wire anode. When the deposition of cadmium is complete, the cathode is removed quickly and washed immediately, once with water and twice with alcohol. After drying on a steam plate it is cooled and weighed.

The polysulphide used for precipitating the sulphides is made up by saturating 500 c.c. concentrated ammonia, containing an excess of powdered sulphur, with hydrogen sulphide; 200 c.c. ammonia is added, and the gassing is continued for two more hours. After filtering the excess sulphur, 100 c.c. ammonia is added, and the solution is stored in dark-colored bottles.

If the determination calls for lead only, the following method may be used: Zinc (100 grams), to which has been added one gram of ferric sulphate, is dissolved in nitric acid, in a 2,000-c.c. beaker. After dilution with water the iron is precipitated with ammonia. The ferric hydroxide, which carries down the lead, is filtered on a filter paper of medium texture, washed with hot water, and dissolved on the funnel into the original beaker with hot 1:1 hydrochloric acid. The solution is fumed after addition of 15 c.c. 1:1 sulphuric acid, and the soluble sulphates are dissolved in 50 c.c. water. The lead sulphate is filtered, washed with cold water, and dissolved in ammonium acetate as previously described.

Lead may also be determined by the following electrolytic method, if cadmium is not called for. This method may also be used for determining lead in copper and cadmium: for accurate work a sample of 86 grams of zinc is placed in a 1,500-c.c. beaker and dissolved in 320 c.c. nitric acid, sp. g. 1.42, and 100 c.c. water. Two grams of calcium carbonate is added, the solution is diluted to 800 c.c. with hot water, and then made strongly ammoniacal. It is then brought to boiling and precipitated with two to five grams of ammonium carbonate, giving a quick-settling precipitate of calcium carbonate that carries down the lead. The solution is decanted through a filter paper and the main bulk of the precipitate is washed into a 250-c.c. beaker, the remainder being dissolved on the paper with 3 c.c. nitric acid, diluted with 20 c.c. water.

A few drops of silver nitrate solution and 1 c.c. of strong copper nitrate solution are added, the solution is diluted to 200 c.c. and electrolyzed with 0.5 to 1.0 amp., using a platinum gauze anode and a wire cathode. After about two hours, when the decomposition should be complete, the anode is removed quickly, washed by immersion, twice in water and once in alcohol, whereupon it is dried for ten minutes at about 110 deg. C., and weighed after cooling. One milligram equals 0.001 per cent lead, for an original sample of 86 grams.

To obtain an adhering deposit of lead peroxide, an anode roughened by sand blasting or by long use must be employed. The anodes should be tested with known amounts of lead, as some of the cylinders do not take lead in such small amounts. A blank should also be run, containing about the same amount of lead as the sample, and corrections should be made accordingly. The nitric acid, particularly, often contains traces of lead, which would interfere with the result if no blank was used.

For rapid determinations with comparatively high amounts of lead a sample of ten grams is dissolved in 110 c.c. of nitric acid. After boiling to expel the nitrous fumes the solution is cooled, diluted to 225 c.c., and electrolyzed as described.

For determination of iron a sample of ten grams is washed lightly with dilute hydrochloric acid to dissolve any iron held mechanically on the surface, followed by water to remove the hydrochloric acid. The zinc is then dissolved in nitric acid; the solution is diluted to 100 c.c. in a measuring flask, and 10-c.c. samples, each containing one gram of zinc, measured with a pipette into 100-c.c. beakers, are boiled to expel the nitrous fumes.

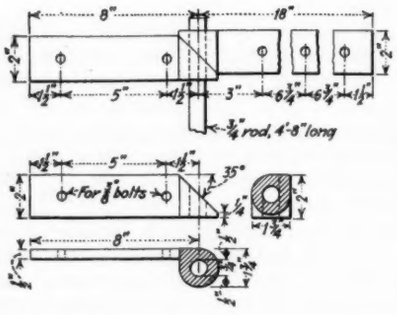
After cooling, 15 c.c. ammonia and one drop of weak permanganate solution are added; the solution is boiled until the precipitate coagulates, filtered, washed twice with 1:1 ammonia to dissolve most of the zinc, and then twice with water. The precipitate is dissolved on the filter into the original beaker with 10 to 20 c.c. weak nitric acid (one part of acid to eight parts of water), and the paper is washed three times with water.

The solution is diluted with water to 100 c.c., and cooled; 2 c.c. ammonium sulphocyanate is added, and the color of the solution is compared with that of a standard taken through the process with the sample. Measured amounts of an iron solution of known strength are added to the standard until the color matches that of the sample. The ammonium sulphocyanate solution is prepared by dissolving 100 grams NH_4CNS in 200 c.c. water.

I am indebted to Mr. Frederick Laist, general metallurgical manager, Anaconda Copper Mining Company, for permission to publish these data.

Gravity Hinge for Ventilation Doors

AN important item in the design of an underground ventilation door is the arrangement for automatically closing it after the operator or haulage train has passed through the opening. The many simple and popular methods employed in recent years include the application of springs, counter-weights suspended from steel cables attached to the door, and compressed-air contrivances, all of which are satisfactory from a mechanical standpoint but costly to operate because of the expense involved for installation and maintenance. To avoid such expense, the gravity hinge shown in the accompanying sketch, requiring but a periodical oiling of the hinge section, was developed and adopted as a standard at the Pilares mine of the Moctezuma Copper Company, Pilares, Sonora, Mexico. The operating principle is simple: During the opening period the spiral cam movement of the beveled hinge sections slowly raises the door to the corresponding height of the hinge bevel, from which point it returns by gravity to its original position. To insure a smooth-operating door, additional play must be given to the hinge section on the door proper by drilling the hole $\frac{1}{8}$ in. larger than the rod that connects the two hinges, which are made of $\frac{1}{2}$x2-in. strap iron, with forged or milled bevels.



CO-OPERATION BETWEEN CONTRIBUTOR AND EDITOR

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Origin of Chilean Nitrate

Bjarne Hofseth

THE Chilean nitrate pampa is about 700 kilometers long, with an average width of about 50 kilometers. Only small parts are rich enough to be commercially utilized. The average elevation above sea level is about 900 meters, but nitrate has been found as high as 4,000 to 4,500 meters.

To the east of the nitrate pampa is the High Andes cordillera to an elevation of more than 4,000 meters, with many peaks up to 6,000 meters. To the west is the Coast cordillera, with an average width of about 60 kilometers from the nitrate pampa to the sea, and an elevation of 1,200 to 1,500 meters. In the great longitudinal valley between these two mountain ranges lies the nitrate pampa, mainly on the eastern slopes of the Coast cordillera, along the foot of which flows the Humboldt current, which is one of the main causes for the existence of the nitrate deposits. It carries immense quantities of cool water, prevents rain from falling on the nitrate pampa, and influences the movement of the air across it. This relatively cool water is exceptionally rich in marine life. A few years ago, when the current strayed away from the coast, the liners reported passing through miles of water covered by bodies of birds that died because their food supply had failed them.

The productivity of the Humboldt current in terms of nitrogenous matter may be judged by the number of birds to be seen living off the water or by the amazing quantities of guano produced by these birds. In fact, one of the many theories advanced to explain the origin of the nitrate deposits is that they were formed by particles of guano blown from the sea coast by the regular winds, and accumulated and mystically metamorphosed in the nitrate deposits. The scientists who advanced this theory might be partly right in crediting the life in the Humboldt current with the work of originally assimilating the nitrogen, and also right when they credited the wind with the work of transporting the nitrogenous products across the Coast cordillera. Almost every day there is a fairly strong wind blowing from the sea to the nitrate pampa. The speed of this wind and the length of time it blows every day might well have been planned for use as a means of transport for nitrate material from the sea and from the surface of the Coast cordillera to the nitrate pampa and no further. I have estimated the wind velocity at an average speed of about 5 meters per second for 2,000 hours a year. This gives an average daily movement of just below 100 kilometers.

Each forenoon, when the sun has had time to prepare the rock surface and the air, the wind starts. It blows from the Humboldt current, up the steep cordillera. Fine dust is carried forward and thrown against exposed rock-surfaces. I have seen boulders regularly potholed by such bombardment by wind, which employs chemical and mechanical means of attack. The finest product of this chemical and mechanical erosion is swept forward by the wind. When the day is ended and the wind stops its work, a load of dust from the Coast range has arrived over the nitrate pampa, where it remains suspended in the quiet air. While cooling in the night, various vapors or gases present in the air are attracted to the surface of the minute particles and help to settle the dust. This process is often extensive enough to show in the formation of a wet fog, locally called *camanchaca*. As this dust or fog settles, it lays the contained soluble salts in all tiny cavities of the pampa surface, where they gradually form a thin crust.

Only small quantities of dust need be transported and treated every year to account for the nitrate deposits. Assume 100,000 years has been taken to build the present nitrate deposits, containing about three thousand million tons of possibly commercially important $NaNO_3$; this figure is possibly much too high, but I select it because it is the highest I have seen mentioned in any serious and apparently well-informed estimate of the available quantity of nitrate. Assume that this three thousand million tons is no more than 5 per cent of the total nitrate formed, the remainder having gone elsewhere. Suppose the crust formed contains only 5 per cent $NaNO_3$, the remainder made up from other soluble salts, with some clay and other insoluble residue of rock minerals. Then the crust accumulated over each period of fifteen years over the entire area of the nitrate pampa need have an average thickness of only 2½ millimeters, or 1/10 in., to account for the nitrate deposits.

This crust accumulated by the action of wind and *camanchaca* is dissolved and precipitated deeper in the ground by the action of rain water. Ordinarily, only a few minutes of rain will fall at intervals of one or more years. But occasionally the Humboldt current strays away, and floods occur. Such heavy rainfall has been registered eight times since 1819, with an average interval of 15.1 years. The last time this happened was in 1925. For about three weeks we had an abnormal climate, and the local newspapers were full of reports of damage done by flood water.

During such periods of changed climate the nitrate-bearing accumulations on the eastern slope of the coast cordillera are washed down and rearranged, until commercially valuable deposits are created. Many factors influence this redistribution, such as quantity and temperature of water, quantities and degree of solubility of the various soluble salts, depth and character of the porous material on the pampa, topography and character of the bedrock; also the temperatures or quantities of heat stored in the ground when and where the salts are dissolved and again precipitated from solution as the water cooled during evaporation.

Although the air current from the sea over the Coast cordillera is by far the most important agency in the production of nitrate and nitrate deposits, some aid may result from the effects of a counter current of air from the High Andes to the sea. This counter curretn is rarely felt on the nitrate pampa in the longitudinal valley. It probably goes on a high level from the Andes to the ridge of the Coast cordillera, at the foot of which it is felt as a wind blowing offshore, in the night. While flowing down the slopes of the Coast cordillera this current may help to keep fresh rock surfaces exposed, by bringing down the remaining products of erosion, too resistant to chemical and mechanical attack to be finely pulverized—mainly quartz. This quartz-sand may be expected to be blown into gulleys, from which occasional flood water will transport it to the sea.

The air coming down from the High Andes will carry with it volcanic gases. Volcanoes are numerous; several emit gases continuously. In fact, a few years ago a mining company investigated the possibility of utilizing one of these volcanoes as a regular source of power. Part of these volcanic gases reaching the sea will follow the nitrate-producing air current uphill next forenoon.

The Coast cordillera contains great quantities of igneous rocks, of a soda-content much above the average in rocks. But assuming a content of sodium not higher than the average in the earth's crust, and with the same rate of production of nitrate, as in the foregoing, an average denudation of the Coast cordillera of one inch for every 70 years is needed to supply 100 times more sodium than what is contained in the

three thousand million tons $NaNO_3$ supposed to be available at present on the nitrate pampa. This sodium is present mainly as soda in feldspars, and is, together with potash, the first component to go when the rocks are subjected to the common forces of erosion. The soda will form salts with the strongest acids available. Some soda is also supplied from other sources, such as the bedrock of the nitrate pampa.

In Clarke's "Data of Geochemistry" are given data referring to the amount of fixed nitrogen precipitated from the atmosphere by rain at eleven different points of observation. The average is given as 4.13 lb. per acre per year. If such an average yearly quantity had been accumulating over the nitrate pampa for 100,000 years, and if none of it were lost, the amount would have roughly equaled the quantity of nitrogen in about ten thousand millions tons of $NaNO_3$.

The Chilean nitrate deposits have been formed by the action of wind and water on products of decomposition of the rocks between the nitrate pampa and the sea.

The basic radicles for the various salts contained in the nitrate beds have been supplied by the rock-forming minerals in the Coast cordillera, and the acid radicles by gases contained in the air current regularly rising from the sea. This current carries not only ordinary air and ordinary products from evaporation of sea water, but also products of decomposition of the exceptionally rich marine life in the Humbodlt current, and gases from the active volcanoes in the district. The commercially valuable portions of the nitrate pampa should be considered as secondary deposits, drawing their material from the nitrate-bearing dust continuously settling from the atmosphere.

The key to an understanding of these secondary deposits, and consequently the best aid to their location, should be found in a study of the complicated conditions that guide the flow of the nitrate-bearing solutions, and the precipitation of nitrate from such solutions.

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Drilling From a 47-ft. Column

The 47-ft. drill column employed at the Rialto mine, in the Tri-State district

DRILLING from a platform clamped to the top of a 47-ft. drill column is, relatively and figuratively speaking, "getting up in the world" for a metal miner. Such an elevated position has recently been a daily experience for several miners at the Rialto mine, in the Tri-State zinc-lead district, during the removal of a 15- to 20-ft. layer of ore from the roof of old "high" workings.

The column, shown in the accompanying illustration, is made of welded sections of 4½-in. double-strength pipe. A total length of 34 ft. was used at the beginning, then 8 ft. more was added, and finally another 5-ft. section, making the column 47 ft. long. Standard large-drill fittings are used. The platform, made of 2-in. pipe, measures 4 by 8 ft., and is braced to a safety clamp, 8 ft. below.

In erecting the column, a ladder is first raised close to the point in the roof where the top of the column is to rest. From this point a plumb bob is then suspended, to determine the correct position for the base of the column. By means of block and tackle attached to the top of the ladder, the column is then raised and jacked lightly into place. Little pressure is used, as otherwise the column would bend. The drilling platform is then raised, clamped onto the column, and covered with 2-in. planks. As soon as the drill has been raised and clamped to the column arm, a short hole is drilled into the roof near the top of the column. Into this hole a piece of steel is wedged, and the column fastened to the steel with a chain. This precaution is taken to prevent the column from falling, should vibration of the drilling loosen it. The round, comprising 5 to 8 holes that vary in length up to 24 ft., is then drilled.

The drill used is a Cleveland D9 drifter, with 3⅜-in. bore, 2¾-in. stroke, and a long guide shell. This particular drill was employed because of its comparative freedom from vibration and on account of its ability to function with the long drill steels employed.

Roof-removal operations of a similar character have previously been performed in the Tri-State district by erecting a scaffold from the floor of the workings to the roof, and then moving and adjusting the scaffold as required for various working places. The aforementioned steel-column method, however, is said to be the most economical and practical that has been developed in the district.

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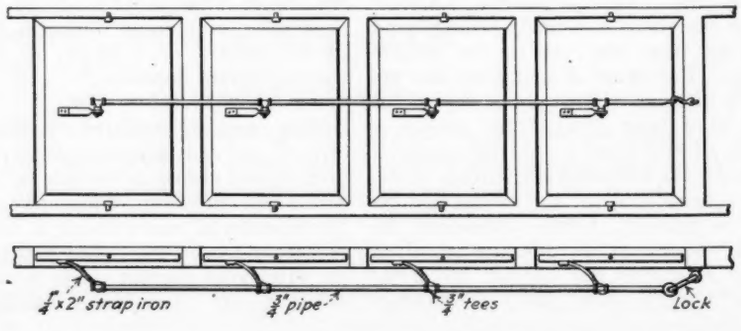
Window Opening and Closing Device

Ventilating doors or windows, installed in series, need considerable attention if they are not equipped with some efficient device to effect a uniform opening and closing of each unit. The simple contrivance, developed and installed at the power house of the New Cornelia mines of Calumet & Arizona, at Ajo, Ariz., to accomplish this purpose, is of interest. As shown in the accompanying sketch, each window is equipped with a short strap-iron lever attached to a long connecting rod, made up of several short lengths of ¾-in. pipe and ¾-in. tees, which when moved to the left opens all doors simultaneously to the distance desired. When the doors are required to be shut, the rod is pulled back and locked with a small hook provided on one end of the door frame.



Turning and Milling

Large Rod-Mill Gears

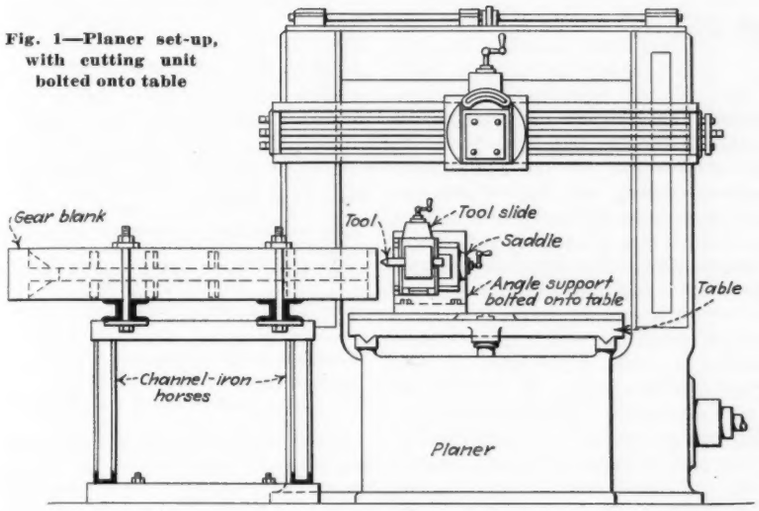


Fig. 1—Planer set-up, with cutting unit bolted onto table

OF THE many problems confronting the mine, mill, or smelter master mechanic, the turning and correctly milling of large gears economically is difficult, because of the usual lack of a lathe or milling machine sufficiently large to accommodate the cast gear blank. Special set-ups, jigs, and mechanical changes on the available standard machines are generally required to turn the two operations into a matter of routine.

The mechanical department of the Moctezuma Copper Company, at Nacozari, Sonora, Mexico, faced with the necessity of manufacturing several large rod-mill gears, and devoid of special machines, solved the problem successfully with the ingenious set-ups and fixtures to be described. The first difficulty encountered, because of the non-availability of a suitable planer, was the planing of the gear section ends. Unable to place the half gear on the reciprocating table of the planer, and no side head being available, the set-up illustrated in Fig. 1 was employed. The half gear, in this instance with its ends placed as near the planer table as possible, is mounted and carefully attached to two sturdy channel-iron horses anchored to the cement floor by four bolts. Obviously, the cutting unit, bolted onto the planer table, and consisting of an angle support equipped with a small saddle and a tool slide, replaces the side head otherwise required.

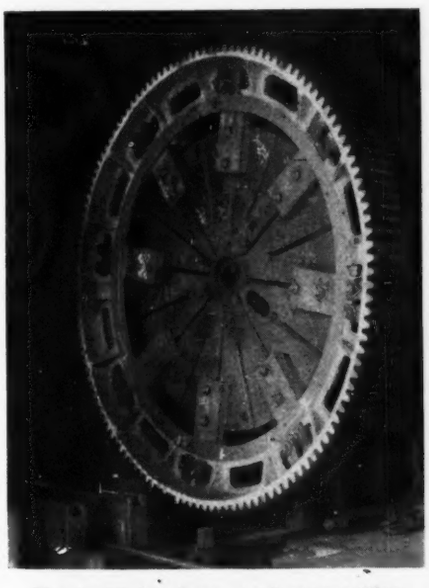


Fig. 3—Finished gear and gear-cutting arrangement

A far more difficult problem, however, was the turning of the gear blank and the milling of the teeth. The lathe being too small to accommodate the gear, and with no gear-cutting machine available, this difficulty was overcome by placing a carefully machined cast-iron supplement between the lathe bed and the spindle support, thus raising the lathe spindle and face plate fitted with eight heavy flat-iron bolted-on bars, and providing the necessary room for mounting and centering the gear blank; and by constructing an attachable milling unit—incline support bolted to one side of the lathe bed, a cross-slide and compound rest, and milling unit proper containing the cutter arbor and cutter,

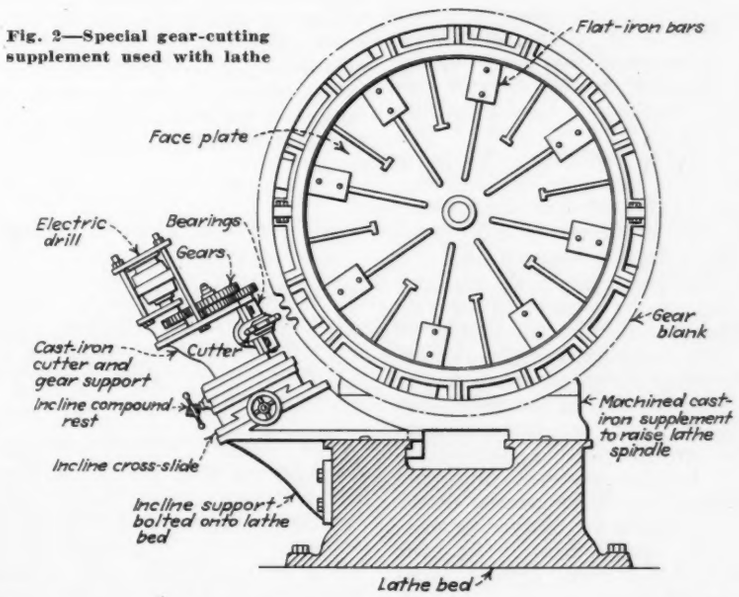


Fig. 2—Special gear-cutting supplement used with lathe

resting between two bearings, and a gear train, as shown in Fig. 2.

The cutter is actuated by the small electric drill attached to the taper shank of the last pinion, and held in place with four long bolts and a cross bar. To expedite milling operations, the teeth are cut in two stages: First, a guide cut is made with a rougher cutter, which is followed by the finishing tool. A finished gear manufactured with the described methods is shown in Fig. 3.

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FIELD MAPPING
. . . Practice and Philosophy

A Review by Frank H. Probert

METHODS IN GEOLOGICAL SURVEYING. *By Edward Greenly and Howel Williams. New York: D. Van Nostrand Company; $7. London: Thos. Murby & Company, 1 Fleet Lane; 17s. 6d.*

MANY men have knowledge of a subject but fail in an attempt to impart it to others: the gift of exposition is rare. Huxley's essay on "a piece of chalk" is an outstanding example of unusual ability to express in pure, simple language advanced scientific thought: the pleasing presentation sustains interest and carries conviction. Technical dissertations seldom deserve classification as literature. It is refreshing, then, to find a modern textbook, wherein technologic procedure, sincerity of scientific observation, clarity of thought and beauty of expression are so appealingly combined as in Greenly and Williams, "Methods in Geological Surveying."

The object of the book is to discuss the aims and technique of field mapping; the job is well done, for not only are the niceties of the exacting work explained in logical sequence and lucid manner, but the reader feels the companionship of the writers as together they tramp the terrain and analyze its make. The engaging style, the delightful digressions which serve not to tire but to stimulate, bring the field party to camp at night, leg-weary perhaps from the long journey but mentally exhilarated by the sermons in stones revealed to them in the perusal of the page as it pictures the "pervading mystery" of the earth's crust. The mute testimony of the rocks appeals to us in thunderous tones.

My purpose, however, is to review rather than to exalt this acceptable contribution to the technical bookshelf. The authors are men schooled in the ways of the British official geological surveys, broadened by experience in the methods of the United States. They combine the culture and craft of both countries, and, as they write with authority, we hang upon their words. As do all field geologists, they follow "The method of Zadig," yet they emphasize the need "for separation of observation from inference; for exactitude in location of evidence; and for the view of geological maps as real works of art." The historical treatment of cartography serves as a fitting introduction to the particular work of geological surveying. With painstaking effort the technique is developed: appropriate description of the tools is given, but the reader is spared duplication of trade catalogs, just enough being said to indicate the use and usefulness of the several instruments. I read into the treatise an honest attempt to excite the imagination and to promote endless questioning of Nature's work: to progress from hypothesis to truth: to weigh all evidence circumstantial and inferential before expressing a conclusion as a mark on the developing map. The constant warning against guesswork is commendable. A strong plea is made for uniformity in symbols and signs, for the elimination of superfluities, that a map be a map rather than a maze of meaningless lines or patchwork of confusing colors. The advice to collectors of specimens is sound, as is that on the importance of note-taking, of sketching, and other helpful illustration. The notebook is "a repository for detail and ideas." "The strongest memory is apt to fail occasionally."

A chapter is given to "Suggestions"—would that they were injunctions! In these days of desecration and arrogance some there are who still respect the doctrine of *noblesse oblige*. "Nor must we ever deface the beauty of the country. . . . It must be a point of honor to leave behind us no trace of our presence." Stress is laid upon one's attitude of mind in the field: the admonition is worth while, for the proper balance of mental recreation with bodily exertion promotes efficiency and well-being. "The aspect of nature is transfigured" by the contemplation of the sublime expressions of the poets.

"That night the country never seemed so still;
The trees and grasses spoke without a word
To stars that brushed them with their silver wings.
Together with the moon I climbed the hill,
And, in the very heart of Silence, heard
The speech and music of immortal things."

Some may be disappointed by the omission of mention of the economic aspects of geological surveying and the bearing which it has on potential industry. Others might wish for more than casual mention of instrumental or geophysical search, but apparently these subjects were purposefully left untouched. The book is satisfying as it is; it should be widely read by all students of the geological sciences: there is much meat in it for the mature. I commend it to the profession at large.

■ ■

COHORT OF THE TROPICS. *By Owen Letcher. Pp. 94; 11¼x9 in. London: Waterlow & Sons, Ltd., 26 Great Winchester St., E.C.2. Six shillings; postage extra.*

A VERITABLE HOST of those who participated in the Great War, in field and swivel chair, have since the Armistice sought to rid their minds of memories of that experience and suffering by transferring into permanent literary form the record of those dark and fearsome days. The nations that sacrificed have relived to the full in the literature of retrospect and anguish of the drama of those years. Luckily for English readers, Africa stayed her hand for a decade or so in her contribution to the flood of war books, and the short volume under review, written by a mining engineer who is also the Johannesburg editorial correspondent to *Engineering and Mining Journal* is the better for the influence of the softening effects of time.

"Cohort of the Tropics," though mitigating nothing of the essential nature of war, permits much of the lighter and human side of organized slaughter—for such war is—to filter through Mr. Letcher's sketchy and sprightly record of the British-German campaigns in South Africa. It takes the form of 29 short chapters, which flash vividly upon the printed page the high lights of a series of military episodes of minor weight in the military struggle, but comprising all their small world to the gallant companies of both British and Germans who "carried on" in British and German Africa. Mr. Letcher writes poignantly and sincerely, but, at that, the volume evokes many more smiles than tears. Though in no smallest sense an attempt to record the technique of the strategy of British-German operations in African jungle and plateau, the reader discerns at once that the "waiting" policy of the Germans in South Africa, confident that the War would speedily bring victory to them on the major front in France, prevented many engagements that if an offensive policy had been ordained would have prepared inevitably for us all a much more bloody record for the "tropics." For this small blessing, not patent in 1914-18, we may now be thankful.

War strips humanity of its garments of the ages; and Letcher's bold penciling shows it naked and incapable of shame. His characters are cameo-like and vivid. The love episodes that record the romance of Saunders of the

Intelligence and Olga Von Höhenel, a patrician Austrian, flotsam on the crest of circumstance, are truly splendid writing. In them the reader discerns truth that even war may not submerge.

Those of us who lived through the Great War know all too well that its history—on any front—will never and can never be written, for humanity's experience in that welter of hate and error is beyond recording; but of such as may be put into the record of books, Mr. Letcher's contribution deserves mention and a place. Translations into German, French, Italian, and Russian, and republication in the United States, would further effect the purpose of the author, which is again to repeat and emphasize, and in a fashion that will be read and pondered, and that will amuse too, the hellishness, madness, and silliness of war.

W. N. P. Reed.

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Handbook of Scraper Mucking. *By the technical staff of the Sullivan Machinery Company, Chicago. Publication No. 176; $2.*

In contrast to other books on scraping, this volume treats the subject from the viewpoint that the elements affecting the problem should be analyzed and that their importance in affecting the results secured should be appraised quantitatively. The principles of practice established are based on a careful study of many actual installations. The 118 pages are divided into sixteen chapters, the topics of which will indicate the treatment. They are: advantages of scraper mucking; elementary set-ups; notes on scraper design; equipment and accessories; hoists; capacities of scrapers and hoists; scraper mucking with car-loading slides; scraping in flat, thin deposits; scraping in steeply pitched narrow veins; scraping in glory holes and mill holes; scraping in horizontal cut-and-fill stopes; scraping in square-set stopes; scraping in top-slicing and in sublevel caving; scraping in tunnels and development work; and miscellaneous uses of scrapers. Operators will find the book most useful.

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Mining Year Book. *By Walter E. Skinner. Londons Walter E. Skinner, 15, Dowgate Hill, E.C. 4; 21s. 6d.*

A total of 1,420 mining companies are listed and analyzed in the pages of the 1931 edition of this annual year book, covering operations in every part of the globe. The care with which it is edited and the last-minute character of much of the information make this book a valuable addition to the library of every itinerant mining engineer. The editor has added this year a considerable number of companies not previously listed, including several important undertakings.

Elementary Economic Geology. *By H. Ries. Pp. 360; illus. New York: John Wiley & Sons; $3.75. London: Chapman & Hall; 18s. 9d.*

This volume provides, in small compass, essential information on the metallic and non-metallic minerals of commerce. It covers the origin and characteristics of ores and their classification, chemical and physical properties of products, geological and geographical distribution, brief notes on preparation, and considerably more detail as to uses and applications than is to be found in the author's standard textbook, "Economic Geology," now in its sixth edition. Grouping of matter is the same in the two volumes. The variety and comparative importance of the so-called non-metallics is stressed by major space allotment in the first twelve chapters, comprising Part I. Part II commences with a summary treatment of the geology of ore deposits, followed by separate sections on the ores of each of the major and minor metals, with supplementary information characteristic of the general plan followed throughout the book.

"Elementary Economic Geology" was designed to provide a text for a one-term course in the subject; but it should, in addition, find a wide audience among operators and engineers who are not geologists, but who require authoritative information in convenient form for reference or study purposes.

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The Menace of Overproduction. *By Scoville Hamlin. New York: John Wiley & Sons; $2.75. London: Chapman & Hall; 13s.9d.*

OVERPRODUCTION and its concomitant evil, unemployment, have been with us long enough to make their influence directly felt in the lives of all. They present a problem crying for solution, a problem which must be faced by those in whom the responsibility for the guidance of the nation's life is vested. Mr. Hamlin's book is timely, and should be received with interest by all to whom the needs of the hour constitute a challenge.

Each of the eighteen different phases of industry is discussed by an authority in his field. The unanimous verdict in regard to the seriousness of the situation is startling. The contributors talk straight from the shoulder, in a manner so direct and unveiled that he who runs may read, a decided advantage in this fast-moving age. One is left with a vivid picture of the lack of co-ordination and planning, the shortsighted methods of competition, the narrow views held by many who are supposed to lead, the entire disregard to the conservation of natural resources, and the tremendous waste and loss suffered by society and individuals from these causes. The opinion is also general that the time of limited, nationalistic views is passing, and that a better understanding among the different nations and races is needed to pave the way to better and more stable conditions.

In his final summary Mr. Hamlin reiterates and amplifies the conclusions drawn by the individual contributors, supplementing additional suggestions for remedying the situation. Among his ideas the suggestion to treat labor as an investment bearing fixed overhead charges should arouse much interest.

B. H. Strom.

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Received

Report of the State Geologist on the Mineral Industries and Geology of Vermont, 1929-30. *By Geo. H. Perkins. Pp. 265. Burlington, Vt.: Free Press Printing Company.*

Keystone Coal Buyers' Catalog and Mine Directory. *New York: McGraw-Hill Catalog & Directory Company; 854 pp., illus.; thumb indexed; $15.*

Why Recognize Russia? *By Louis Fisher. Pp. 298. New York: Jonathan Cape & Harrison Smith; $2. London: Jonathan Cape and Harrison Smith, Ltd., 30 Bedford Square.*

Policy and Ethics in Business. *By Carl F. Taeusch. Pp. 624. New York: McGraw-Hill Book Company; $5. London: McGraw-Hill Book Company, Ltd.; £1 5s.*

Soviet Foreign Trade. *By J. M. Budish and Samuel S. Shipman. Pp. 276. New York: Horace Liveright, Inc.; $2.50.*

Geology of the Eminence and Cardareva Quadrangles. *Volume 24, Second Series. By Josiah Bridge. Pp. 228; illus. Rolla, Mo.: H. A. Buehler, Missouri Bureau of Geology and Mines.*

Geology of the Potosi and Edgehill Quadrangles. *Vol 23, Second Series. By C. L. Dake. Pp. 233; illus. Rolla, Mo.: H. A. Buehler, Missouri Bureau of Geology and Mines.*

Biennial Report of the State Geologist. *Missouri Bureau of Geology and Mines. Pp. 151; illus. Rolla, Mo.: H. A. Buehler, Director and State Geologist.*

Digest of Mining Laws of Canada. *Ottawa: Mines Branch of the Department of Mines. Report No. 713, available on application to the director.*

Geomagnetic Survey of the Bauxite Region in Central Arkansas. *By Noel H. Stearn. Arkansas Geological Survey, Little Rock. Pp. 16, with several maps.*

Laboratory Concentration of Missouri Iron Ores of Iron Mountain and Pilot Knob. *By F. D. De Vaney and S. R. B. Cooke, Bureau of Mines and School of Mines, Rolla, Mo.*

Regulations of the Mexican Mining Law. *Issued by the National Chamber of Mines of the State of Chihuahua, 604 Ocampo Ave., Chihuahua, Mexico. Pp. 75. Price, postage prepaid and c.o.d., $2.50.*

Potash Bibliography in 1929. (Annotated). *By J. F. T. Berliner, Bureau of Mines, Washington, D. C. Pp. 578. For sale by the Superintendent of Documents, Washington. Price, 90c.*

Among Contributors To This Issue:

BJORN P. F. KJELLBERG, who has contributed before to these columns, was graduated from the School of Mines, Stockholm, in 1891. He was appointed Assistant State Inspector of Mines of Sweden, in 1895, and State Inspector in 1902.

L. D. STEWART has been associated for several years with Oglebay, Norton & Company, in charge of electrical and mechanical construction and operation at various properties controlled by the company in the Lake Superior iron region.

WILLIAM J. LORING began his underground career at the age of twelve, as a tool boy in a Mother Lode mine. After gaining valuable experience and achieving technical and executive success on several California properties, he became associated, in 1902, with Bewick, Moreing & Company, as superintendent of the Sons of Gwalia mine, in Western Australia, later being appointed general manager of the many Bewick-Moreing properties in that State. In 1908, he acquired Mr. Hoover's interest in the firm, and established headquarters in London. In 1914, he returned to California, to assume the direction of various Western mining operations. In recent years he has been actively associated with the development of the Hammon Copper Company's property near Kirkland, Ariz.; and latterly, with precious-metal mining in Nevada.

FRANK H. PROBERT is well known to readers of this magazine because of his inspiring and scholarly contributions to current technical literature, indicating thoughtful analysis and scientific reasoning in a philosophic strain. Subsequent to graduation as an Associate of the Royal School of Mines, London, Mr. Probert practiced his profession as an examining engineer and consultant, and as manager of mines and metallurgical plants in Canada, Wales, Germany, and the United States. He has taken an active part in governmental and society activities in the mining industry, especially since his appointment, in 1917, as Dean of the College of Mining, University of California.

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George A. Clayberg, formerly of Beatty, Nev., is now at Oatman, Ariz.

J. M. Hill has gone to Alaska, where he will be engaged in geological work.

Philip D. Wilson sailed on May 8 for England and the Continent on a two to three months' business trip.

M. Bellebouche, chief engineer of mines of the Boleo company, Santa Rosalia, Baja California, Mexico, is on a five months' trip to France.

John B. Swift, former president of the Eagle-Picher Lead Company, has resigned as chairman and director of that company. No action has as yet been taken to fill the vacancy.

John T. Norton, associate professor of metallurgy at the Massachusetts Institute of Technology, has received a fellowship from the American Scandinavian Foundation, for the purpose of studying metallurgy in Sweden.

Charles H. Gallagher, of Butte, Mont., has presented his collection of mineralogical specimens to the Montana School of Mines. The collection contains over 2,000 items from various parts of the world, and is especially complete in the gold section.

J. H. Sampson has been appointed engineer in charge of operations of the newly formed Benguet Exploration Syndicate, to operate in the Philippine Islands. Mr. Sampson is a graduate of the College of Mines, University of California, class of 1927.

O. C. Martin, manager and consulting engineer of the Hoboken copper refinery at Oolen, Belgium, has been spending a month in the United States, where he has received an LL.D. degree from the University of Indiana, and has been present at the marriage of his son.

John Schofield, maintenance foreman for International Nickel, retired early in May, after 26 years' service with the company. He was presented with a gold watch by a group of fellow employees and old friends, and the company will grant him a retirement pension.

Francis G. Hill, mining engineer and research scholar of the Transvaal Chamber of Mines, is in Bisbee, Ariz., to study local mining conditions, particularly mine management and handling of personnel. He recently gave an address on the South African diamond mines before the local Rotary Club.

R. H. Bacon, formerly a member of the technical staff of the Copper Range company, and later of the editorial staffs of *Power Plant Engineering* and *Electrical World,* has been appointed manager of the pump division of Fairbanks, Morse & Company, with headquarters in Chicago.

C. S. Parsons, mining engineer, Department of Mines of Canada, is the author of Memorandum Series No. 47, in which mention is made of an improved method of amalgamation in conjunction with ball milling. Mr. Parsons supplements this statement by the following comments: "We have found that it is almost impossible to get anybody to use stamps, and we have also found that a ball mill does not prepare the ore properly for amalgamation, particularly if the ore is ground in closed circuit with the classifier and the classifier overflow amalgamated. Several small gold properties possess ores that can be treated by amalgamation, and high recoveries obtained. Two or three small properties have copper-gold ores, in each of which about 50 per cent of the gold can be amalgamated; the tailing can be subjected to flotation, and the concentrate shipped to a smelter. A study of the smelter returns indicates, in every instance, that it would pay better to recover the gold by amalgamation.

"What we have endeavored to do is to take care of this situation by amalgamating in closed circuit between the ball-mill discharge and the classifier. We suggest (1) elevating the ball-mill discharge over double-deck vibrating screens, allowing a minus-14-mesh material to pass over rather steeply inclined plates; or (2) passing the ball-mill discharge directly over the plates, the tailing going to a mercury trap and then into the classifier. The oversize on the double-deck screen falls by gravity back to the ball-mill feed. The classifier overflow can go to tables or flotation, or over a second series of plates, the classifier sand returning as usual back to the grinding mill. We have demonstrated in a small pilot unit that this flowsheet will give as high a recovery of gold on the plates as can be obtained from crushing in a stamp battery."

Sir Auckland Geddes, chairman of the board of directors of Rio Tinto, said at the recent annual meeting of the company, in London, that copper could still fall a long way before Rio Tinto would have to worry about producing at a loss. Rio Tinto is in a strong position, having £750,000 true surplus of quick assets, this after spending about £325,000 on the erection of a new concentrator and a sintering plant, and installing other equipment. Its chief difficulty is taxation by the several governments under which it operates. Since 1924, operating profits of more than £10,500,000 have been made, a little more than half of which went to meet tax demands.

PERSONALS constitute an attractive feature of a magazine of this type. Probably the most interesting ones record changes in employment. If a reader is promoted in his organization, or leaves one company to join another, he should keep his scattered friends informed of his movements. Of only negligible interest to the mining fraternity are notifications that short inspection trips and vacations have been taken. Engineers, particularly mining engineers, are normally peregrinating creatures. News items of journeys to little-known districts, or in connection with important missions, are most welcome, especially when accompanied by short personal comment of an informative or critical nature. When notifying us of change of address, the subscriber is urged to say a word or two about himself or one of his friends. At other times, send a note direct to the Editor, remembering that personal or pictorial photographs are occasionally used to lighten the text.

Enlightened Labor Policies

To the Editor of "E.&M.J.":

An item of peculiar interest to those of us who are puzzling over the present state of the metal mining industry appeared in the April issue of the *Midmonthly Survey*, published by Survey Associates, Inc. I quote below:

"How co-operation between unions and management in Colorado Coal has brought one company through the past year with more gains than losses is told in a recent statement issued by the Rocky Mountain Fuel Company, of Denver. Josephine Roche, a former social worker, is president of the company, which is the second largest producer in the State. When she came into control of the company, on her father's death, she immediately put into effect so broad a program of 'square dealing' with the workers that her competitors prophesied her early failure (see *The Survey*, Sept. 15, 1928, page 341). The company's 1930 experience indicates that its enlightened labor policies have helped pay dividends through the slump. Due to the business depression and the open winter, which reduced fuel needs, Colorado's state coal tonnage last year was 17.5 per cent under that of 1929. The Rocky Mountain Fuel Company's production suffered a decline of less than 13 per cent. But despite the fact that lowered production usually means increased costs, the company's 1930 production cost was exactly the same as in 1929. In 1929, the first year the union contract was in effect, costs were cut 19c. a ton below the costs of the previous year. The company's efficiency in production has increased 1.22 tons per man-day in the two years the contract has been in operation. Last year the company's production of 6.49 tons per man-day was 1.79 tons above the state average of 4.7. Accidents were reduced from 145 to 129 in 1930, with not a single fatality. The workers' average annual earnings were $1,770 in 1930, as compared with $2,104 the year before. This was due in part to the reduction in the number of working days and in part to the higher average number of men employed, a policy adopted at the suggestion of the unions."

The Rocky Mountain Fuel Company is a unit in an industry which has suffered for years from the evils of overproduction, senseless competition, and severe seasonal fluctuations. Yet under the terrific strains of the present depression, this concern continues to function to the benefit of both capital and labor.

Mining executives who are conscious of their positions as buffers between labor and capital may well consider Miss Roche's achievements as a guide to their own policies.

JESSE L. MAURY.

Neihart, Mont.

Opportunities for Amalgamation

To the Editor of "E.&M.J.":

I am entirely in accord with the suggestion contained in your editorial regarding the opportunity for the stimulation of small gold-mining operators through the revival of the amalgamation process. I have been preaching this doctrine by correspondence and by interview for a number of years and particularly during the present depression.

Throughout parts of Montana and Idaho with which I am familiar, there are numerous relatively small gold deposits, not large enough to justify elaborate cyanide or flotation plants, the ore from which could and should be treated by simple old-fashioned stamp-mill amalgamation. I say stamp mill, because I still believe there is no device which can compete with the stamp mill as a combined crushing and amalgamating device, particularly if the operator will select his ore carefully and subordinate tonnage to recovery, by the employment of a roomy mortar and inside plates. The modern fast running heavy-duty stamp, with low discharge and narrow mortar, is utterly unsuited for the purpose I have in mind.

Amalgamation has become unfashionable in recent years, but it is particularly applicable to oxidized gold ores, and may even be used successfully with many of the pyritic gold ores. There has been a good deal of scoffing at the old Gilpin County practice, but I have seen millmen at Central City and Blackhawk make from 50 to 70 per cent amalgamation recovery from a pyritic gold ore which would show no gold whatever on the most careful panning. The amalgamation was skillfully done and the ore was crushed in batteries in which the discharge (distance from top of die to bottom of screen) was almost as high as the drop. In other words, the ore was kept in the mortar until a large portion of the gold was liberated from the pyrite and was then in condition to be amalgamated and held by the inside plates. Of course, outside plates should be used also. T. A. Rickard, in his "Stamp Milling of Gold Ores," describes the Gilpin County practice in much detail and traces the steps which led to its adoption. Algernon Del Mar, in his "Stamp Milling," discusses inside amalgamation thoroughly. In my book, "Stamp Milling and Cyaniding," the subject is also emphasized.

Gravity or flotation concentration may follow amalgamation if the operation and the conditions warrant it, of course, or the tailing may be impounded and kept for possible cyanidation later.

As "T. A.," in the preface to "Stamp Milling of Gold Ores"—which, by the way, was his maiden book, I think—so aptly puts it, "The worst of all waste is the waste of experience."

Let us not waste all the years of experience in stamp-mill amalgamation, merely because newer processes have largely, although not wholly, displaced it in larger gold-mining operations.

If I were out of a job tomorrow and had no immediate prospects of employment, I should hie me to the hills, pick up one of the numerous partly developed gold properties in this state or in adjoining states, buy, beg, borrow, or steal an old five- or ten-stamp mill, and go to work along the lines indicated.

FRANCIS A. THOMSON,
President, Montana School of Mines.

Butte, Mont.

Edgar Bush writes from Los Angeles, Calif., complimenting **Bernard Beringer** on his articles on the Witwatersrand, published recently, but taking issue with him in regard to some historical details. Mr. Bush reminisces thus: "When I arrived on the Rand in 1892, before the (second) Boer war, the railhead was already at Vereeniging, on the Vaal River, about 30 miles from Johannesburg, and we finished the journey in mule-drawn Concord coaches. Not very long afterwards we saw the first train arrive in town, probably in 1893. A considerable time previously the Kimberley railway and, later, the Mafeking railheads, on another line to the west, with junction at De Aar had first been used, with a coach trip of twelve hours to Mafeking for passengers, and many days by ox wagon for freight.

"Mr. Beringer may be interested to know," Mr. Bush concludes, "that I first went underground in his home town of Camborne, Cornwall, England, in 1890, climbing down 750 ft. to work in the South Condurrow mine. It used to take us half an hour to go down and three quarters of an hour to come up."

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Obituary

James Letson, Sr., who sat in the first Bisbee city council in 1902, died at his home in Los Angeles on April 30, at the age of 78. A native of Ireland, Mr. Letson came to America in his youth and eventually arrived in Charleston, which is now a small community near Tombstone, but was at that time a thriving town. When Charleston started to decline he borrowed a horse from the Santa Fé agent and went to Bisbee, where he lived for many years. He was a member of the first fire department there—a volunteer organization which had its inception in 1894. He was an active member of the Democratic party and served several terms as chairman of the Cochise County central committee. Mr. Letson and his associates started the Cole shaft in the Warren district and operated several other mining properties. Surviving him are his widow and two sons.

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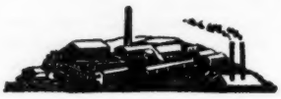
The Last One?

The death of Leonard Matthews, of St. Louis, on May 5, 1931, at the age of 102 years, probably removes the last of the original California Forty-Niners. Mr. Matthews left a farm in Ralls County, Mo., at the age of twenty to join the gold rush to California in 1849, and he was one of the few tenderfeet that made a stake, as he washed out $2,500 in gold from the river gravels in six weeks. He invested it in business in San Francisco, where it grew to $25,000. He returned to St. Louis in 1851, where he spent the rest of his life in mercantile pursuits, finally retiring as an investment banker in 1888, from the house of Matthews & Whitaker. Since then he had devoted his time to his private investments, besides serving on the boards of several directorates. He lived a regular, abstemious life and enjoyed excellent health until almost his last year.

H. A. WHEELER.

St. Louis, Mo.

INDUSTRIAL PROGRESS



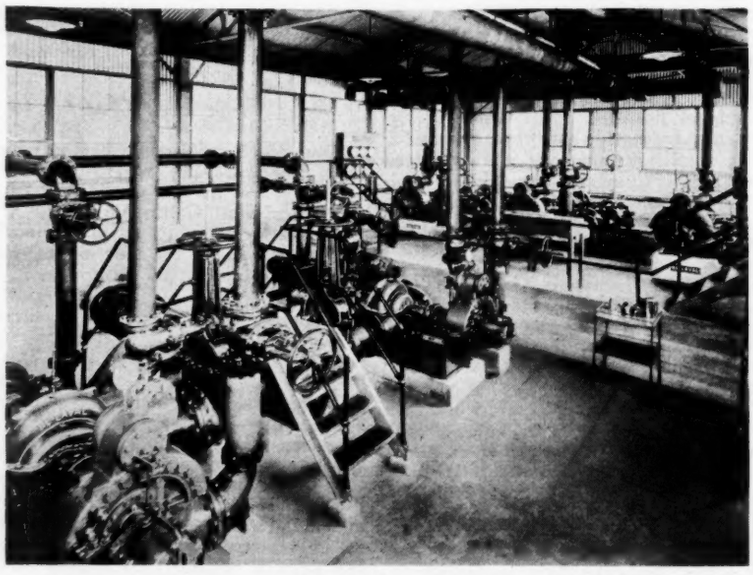
Driving Turbines With Natural Gas a Recent Development

APPLICATIONS of natural gas as a fuel for metallurgical and power purposes are as varied as familiar. A new development of interest, especially to those in localities where natural gas is available and turbines are employed, is the use of the gas for driving turbines, thereby taking advantage of the high pressures at which it usually flows from the well. In the following, an account of this development is given by C. H. Johnston, of the DeLaval Steam Turbine Company, of Trenton, N. J.

Natural gas is found in the deeper producing rock strata at pressures originally as high as 3,000 to 4,000 lb. per square inch in some cases. It exists, possibly, in part as free gas, but inasmuch as methane and ethane, which constitute about 75 per cent of the gas, have critical temperatures below 75 deg. F., the free gas would not be liquefied. At a pressure of 1,500 lb., however, as much as 360 cu.ft. of natural wet gas can be dissolved in a barrel of the lighter oils, so undoubtedly most of the gas is originally in solution where it is found associated with oil.

Gas in solution reduces materially both the viscosity and the surface tension of the oil, and hence also the resistance to flow of the oil through the rock into the well. The formation of bubbles, on the other hand, creates resistance to flow, and production may even cease because the gas pressure has been so reduced as to cause the production of bubbles in the oil, rather than because the oil has been exhausted. For each well there is a certain back pressure which gives a minimum gas-to-oil output ratio, and although, in general, increasing the back pressure on the well reduces the daily production, it will frequently, by reducing the gas to oil ratio, increase considerably the ultimate recovery of oil. At certain times in the life of a well, increase of back pressure may actually increase the daily output.

Inasmuch as it is desirable from the standpoint of production to hold some back pressure on the gas delivered from a well, to seek uses for the energy represented by this back pressure is obviously desirable. The gas under pressure has been used in some instances in gas lifts for pumping other wells, and also for repressuring other wells and forcing the gas through pipe lines to points where it could be sold. As it comes from the well the gas is known as "wet gas," and it is passed through an absorption process which removes all gasoline content, together with water and dirt. Although the gas issues from the well at a much higher pressure, absorption plants are designed to operate at lower pressures, some at 400 to 500 lb. and others at still lower pressures.



Pump room of an oil company's absorption plant at Kettleman Hills, California. The DeLaval turbines shown receive natural gas from Huffman No. 1 well at pressures around 275 lb., the back pressure varying from 75 lb. per square inch down to atmosphere.

The first absorption plant in the Kettleman Hills field in California, built in 1929, was equipped with a modern boiler equipment to provide steam for turbines driving the centrifugal oil and water pumps and for process work, but it was soon found that the water available for boiler use was of very poor quality, and even after water-softening equipment had been installed, much trouble was experienced with the boiler tubes, and the steam entering the turbines carried large quantities of moisture and sludge.

An abundance of natural gas at a pressure of 400 lb. per square inch, and going to waste, naturally suggested its use in the turbines instead of steam. The problem was thereupon submitted to the DeLaval Steam Turbine Company, Trenton, N. J., manufacturers of the turbines, and the engineers of that company, after some research, fitted the turbines with nozzles of special form to take advantage of the expansion characteristics of gas, which are different from those of steam. The gas, which comes from one of the largest gas-producing wells in California, reaches the turbines at around 275 lb. per square inch. As the owner of the plant had a contract to supply fuel gas to neighboring drilling rigs at 70-lb. pressure, the nozzles were designed to expand the gas to 75-lb. back pressure. At other plants, as in the Elwood field, turbines are operated at pressures as low as 45 lb.

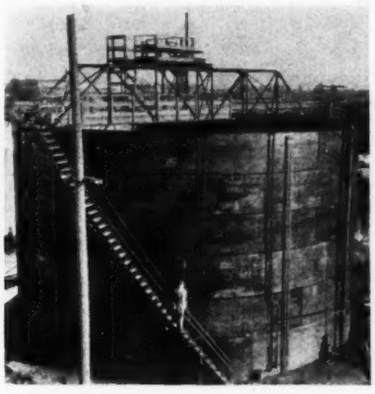
Low-pressure waste steam being also available, those responsible for operations decided to use it for heating the gas to approximately 190 deg. F., thereby materially increasing the energy available from the expansion of the gas and eliminating any possibility of frosting that might result by reason of the refrigerating effect of expansion, the gas leaving the turbines at well above 80 deg. F. At a plant at Kettleman Hills, however, which has not installed heaters, no trouble from frosting has been experienced, the gas entering the turbine at a temperature in the neighborhood of 125 deg. F.

The turbine installation has now been in operation for more than two years and has given uninterrupted service. The turbines, when opened recently for inspection, showed no wear whatever on interior parts, such as nozzles, guide vanes, and buckets, although turbines using steam in the same district show erosion. All pumping for circulation of oil and water is performed by gas-turbine driven pumps. The gas-driven units have proved so reliable that no motor or steam driven pumps have been installed for standby service, and only enough boiler capacity has been provided to take care of stills and three small reciprocating pumps.

In most of the plants in the Kettleman region more than enough gas is available to do all pumping, including rich and lean oils, wild gasoline to stabilizers, and water over cooling towers and through compressor jackets, and some fifteen or twenty additional gas-driven turbines have been installed in various plants other than the plant described, and all are giving economical service and are eliminating expensive boilers and boiler repairs and attendance. Wherever a surplus supply of natural gas is available, substantial savings can be realized by the use of gas-operated turbines.

Softening and Clarifying Boiler Feed Water

Gail Martin



This clarifier is used for filtering boiler-feed water

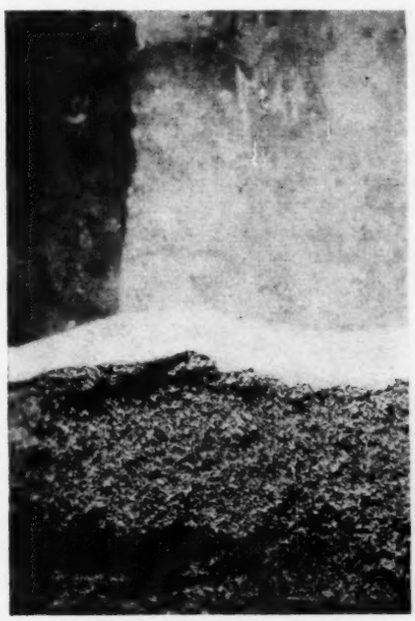
A PIECE of standard mining equipment—the Hardinge sand filter—has been adapted to the problem of water softening and clarification, for boiler use, with conspicuous success, at the plants of the Columbia Steel Company at Ironton, Utah, and the General Petroleum Company at Los Angeles. At both places, the conventional lime-soda treatment is being used. The amount of lime and soda mixed with the water depends upon its hardness.

Mixing is done with mechanical agitators or by maintaining circulation with pumps. The solution is then pumped to a sand filter, consisting of a tank equipped with a false bottom, a sand filter bed, and a spiral scraper mechanism, automatically operated for removing the precipitate and sediment. A small portion of the sand is scraped off the filter bed at the same time, thus renewing the surface at regular intervals and maintaining an active filter bed. This equipment, developed at the property of the Golden Cycle Mining & Reduction Company, at Colorado Springs, Colo., has been used for years for filtering pregnant cyanide solution prior to precipitation of the gold.

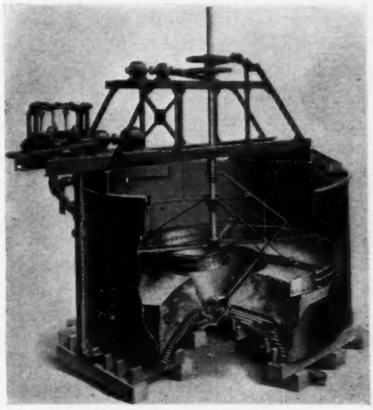
At the Columbia Steel plant, the sand filter is 35½ ft. inside diameter by 15½ ft. deep (approximately 985 sq.ft.). The sand bed is 4 ft. deep, leaving about 12 ft. water head to aid filtration. Under normal conditions, the capacity of the tank is 0.75 gal. per square foot per minute, or 500,000 gal. per 24 hours.

The sand filter at the General Petroleum plant has a diameter of 54 ft. and a depth of 32 ft. At the bottom of this tank is a 5-ft. storage compartment below a false bottom. Five feet of sand is placed on the latter, leaving a 20-ft. water head to aid filtration. This unit, which has never been pushed to its maximum capacity, is operating at the rate of 0.5 gal. per square foot per minute, or 1,750,000 gal. per 24 hours.

Ordinary bank sand, passing a 20-mesh screen and resting on a 200-mesh screen and containing no clay or other foreign material, is used. At the General Petroleum plant, the original filter bed has been in use for five years. It is impossible to state at this time just when it will be necessary to renew the sand. When Columbia Steel emptied its tank for inspection in January after practically two years' use, the sand was found to be in perfect condition. No penetration of lime precipitate or sediment into the sand bed was apparent.



This photograph shows how the finely divided solids film on the surface of the porous bed without penetration



A sectional view of the "super-thickener" and clarifier

The apparatus resembles a thickener. A steel truss across the top of the tank carries the mechanism, which consists of a central vertical shaft, suspended and operated from the truss, having a spiral scraper attached to its lower end. This shaft is threaded at the top, and the weight is carried by the shoulder of a threaded spur gear screwed onto it. A worm driving gear is keyed to the shaft below the threaded spur gear.

As the spiral scraper revolves, it scrapes the solids which have filmed over the surface of the porous bed to the center well. As the scraper is lowered a short distance at each revolution, a minute layer of the porous bed is also scraped to the center well. The lowering is accomplished by a simple device which unscrews the threaded gear at each revolution slightly and allows the whole mechanism to lower. This device is also arranged so that the rate of lowering can be varied or made intermittent to suit requirements. The surface of the porous bed is thus kept

clear and a constant flow of filtrate is secured without having the spiral running continuously. This mechanism is equipped with a 2-hp. motor, and is operated about 20 min. every eight-hour shift, the power consumed being so low as to be almost negligible.

At the Columbia Steel plant, where the sand filter used replaced a rapid sand filter, the advantages were found to be as follows: A saving in the cost of installation; a saving in power; no filter man is needed, since the water tender on the boiler takes care of the filter; the large tank acts as a reservoir or surge basin, so that the softened water always has the same analysis; the sand filter saves softened water because back-washing is not required.

Flow of water is constant and continuous. No further precipitation of solid material takes place after the water has left the filter, because the retention period is sufficient for complete reaction; and the sand bed removes all of the sediment and precipitated material, giving clear water, free from suspended matter.

Changes in Gas Producer Field

Patents and manufacturing rights relating to the Koller gas producer and the Koller mechanical grate, together with the industrial gas equipment formerly manufactured and sold by the Gas Research Company and the Smith Gas Engineering Company, of Dayton, Ohio, have been acquired by the Semet-Solvay Engineering Corporation, of New York. Both of these lines will be further developed and marketed with the present Semet-Solvoy gas and coke plant and welded equipment.

According to report, the Koller grate possesses a number of exclusive features which give high efficiency to gas-producer operation. The grate design is being applied to mechanical operation of carbureted water-gas generators.

The Koller gas producer was originally developed by Karl Koller, of Budapest, to meet the problem of adequate gas yield when using inferior qualities of fuel. Patent rights for the United States were acquired by the Gas Research Company and designs were developed to meet American industrial conditions. The producer has been installed by coke oven, chemical, glass-making, ceramic, steel, and automotive industries.

Data are available showing the cost of operation of these producers using anthracite and bituminous coal of varying analyses. The machine is particularly well adapted to the gasification of coke breeze.

The Smith type of producer is made in sizes ranging from 42 in. in diameter up to 120 in. for gasifying buckwheat anthracite or charcoal. These producers are equipped with a flat shaking grate, central offtake, and a ring feed, with one or three charging hoppers, depending upon the size of the equipment. Where clean gas is required to prevent plugging of small orifices, the producer can be equipped with a sawdust purifier.

Another type of producer, similar in general design but equipped with a side offtake, is built for the gasification of coke or bituminous coal. This equipment, when bituminous coal is used, is furnished with a tar extractor, permitting distribution of clean gas through long pipe lines.

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The Equipment Review

Michigan Pipe Co., Bay City, Mich., offers a wood-lined, alloy pipe for use with acid or corrosive liquids. According to the company, the interior consists of smoothly machined Douglas fir, cypress, spruce, white or yellow pine, or maple staves with longitudinal tongue-and-groove joints tightly installed under heavy pressure. Inside diameter of the wood shell determines the diameter of the pipe. Shell thickness is 1 in. The exterior consists of a light-weight shell of "Toncan" alloy, with flanged ends and A.S.M.E. drilling. The pipe may be secured for pressures up to 200 lb. per square inch. Elbows and tees are available with the same construction.

Advantages listed by the company are: long life; reasonable cost; convenient installation and connection with any bolt circle; exact length lines in sections up to 24 ft. in length; ability to withstand end thrust because of the flanged joints; leakage eliminated by testing all tubes before lining; light weight; no specks, rust, or corrosion; and suitability for either suction or discharge lines.

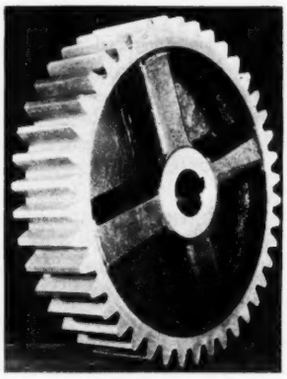
Insulated Aluminum Cables

General Cable Corporation, Rome, N. Y., has announced a varied line of insulated aluminum wires and cables under the trade name "Alectral." Heretofore, it is said, practically all of the aluminum used for the transmission of electrical energy has been in the form of bare conductors. Introduction of the new cable, it is claimed, allows the electrical engineer to employ the economic features of aluminum in a much broader field. The initital group of conductors includes network cable, non-metallic underground cable, insulated line wire, tree wire, armored cables, magnet wire, starter cable, and car-wiring cable. Connections can be made, it is said, by applying high pressure to sleeves by means of a specially designed light-weight, hydraulic press.

For applications where tensile strength is not the controlling consideration, the conductors are all aluminum. For aerial service, certain stranding combinations of aluminum and steel have been developed. These, it is said, will show favorable costs in installation and upkeep in both rural and urban systems. "Alectral" cables, it is said, are materially lighter than the equivalent insulated copper conductors. In both underground and overhead power distribution, insulated aluminum conductors are said to have marked advantages in certain classes of work. System disturbance resulting from underground short-circuits is less with aluminum than with other conductor materials, it is asserted. It also is declared that "Alectral" cables will remain cooler under a given load, as their large cross-section gives greater heat radiation.

New Steel Gears Welded

A line of welded steel gears ranging in diameters from 15 to 168 in. and adapted to heavy duty has been introduced by the Philadelphia Gear Works, Philadelphia, Pa. These gears are said to have approximately 50 per cent greater tensile strength than gears of cast steel, and to offer 30 to 50 per cent longer life. They are said to represent



A welded steel gear

an entirely new departure in materia's, design, and construction. Because the metal is built and not cast, it can be distributed in the welded gear to best advantage, and no consideration need be given to the restriction of molds. No hidden blowholes exist to weaken the structure or to cause tooth failure, and no internal casting strains threaten breakdown. Less abrasive than porcus cast steel, these gears will wear appreciably less on metal-to-metal contact. They weigh about 10 per cent less than those of cast steel and are naturally balanced. The company's entire line of cast steel gears may now be had in the welded form.

NEWS OF THE INDUSTRY

Placer Area Near Yerington Draws Nevada Gold Miners

A placer area discovered on Jan. 10 near Yerington, Nev., is now the center of attention among Nevada gold miners. When news of the discovery leaked out, early in May, a rush to the property followed, and claims have been staked over a total length of 7 miles. The original discoverers, Fred Hughes, R. Carpenter, and D. A. Whittaker, have staked claims about 14 miles northeast of Yerington. They have tested their deposit for a length of 3,000 ft. The richest portion is at the lower end of a gulch, where the deposit narrows to about 50 ft. in width. On May 16, a shaft had been put down 16 ft. in this area, and the estimated depth to the bedrock is an additional 10 ft.

At the head of the gulch, where the placer is within a few inches of the surface, the gold is said to occur in chunks of clay, lying on the bedrock. According to one report, 500 lb. of this section of the deposit was taken to Yerington and run through a cement mixer to break it up. The yield was $200 in gold. Another discovery, in another gulch, is reported to have been made by "Tex" Starr and Dave Bell. Judge C. J. Guild, of the Yerington circuit court, and associates, have located several claims adjoining both discoveries.

Reno, Nev., May 20.—Reports of engineers sent to examine the placer strike at Yerington by John A. Fulton, director of the Nevada Bureau of Mines and of the Mackay School of Mines, attach considerable importance to the strike and the future possibilities of placer mining in Nevada. Microscopic examination definitely places the gold as of the Tertiary period and belonging to the rich Tertiary gravel channels of California. The report says that the Yerington deposit may have been a member of these ancient California river channels or an independent system, flowing east from California. This would support the theories of Adolph Knopf, who, in Professional Paper No. 114 of the U. S. Geological Survey, set forth the possibilities of considerable placer mining in Nevada from ancient river channels.

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Pittsburg-Goldfield Cuts Quartz

The east drift on the 500 level of the Pittsburg-Goldfield mine, at Goldfield, Nev., cut through 17 ft. of quartz last week. The quartz carried some gold, but it was not of commercial grade. The management is considerably encouraged, however, and development of the vein will be continued. The Pittsburg-Goldfield development work is being undertaken with the intention of testing the possibilities of the eastern section of the Goldfield district, once one of the largest gold-producing areas in Nevada but now dormant.

U. S. Agrees to Participate in Silver Conference, But Japan Hesitates

Adoption of a resolution favoring the calling of a conference to study the decline in the price of silver—and its effect on international commercial and financial problems—by the International Chamber of Commerce, which met at Washington early in May, has resulted in at last precipitating some action with regard to such a conference. Perhaps the most important development since the adoption of the resolution has been the announcement, by Under-Secretary of State Castle, that the United States is prepared to participate in such a conference. Support for the conference from India and China seems certain, but the attitude of Great Britain is not yet known, and advices from Japan indicate that a silver committee of Japanese bankers is opposed to holding a conference in Tokyo.

Senator Key Pittman, of Nevada, perhaps the foremost champion of silver in the U. S. Senate, has sailed to China to investigate conditions. Senator William Borah, of Idaho, has insisted in several radio speeches that silver must be restored to its rightful place in the affairs of the world. Also prominent in putting the silver problem before the public within the last few weeks have been Senator King, of Utah, and J. F. Darling, director of the Midland Bank, of Great Britain, now touring in Canada.

Mr. Castle, in announcing the United States' willingness to participate, explained that in view of the fact the interests of the United States were less direct than those of some other nations, the government felt that some nation other than the United States should issue the call for a conference. In view of the reluctance of Great Britain to take action (at the International Chamber of Commerce, her spokesman expressed the opinion that silver, as a monetary metal, was no longer of importance), one of the Oriental countries, probably China, is expected to be the active propagator of a conference.

The five bankers on the Japanese silver committee are reported to have agreed that Japan is not responsible in any way for the silver position and that she should become the figurehead of a movement to aid silver is undesirable. They do not believe that any artificial measure can solve the silver problem. Later dispatches indicate the Japanese Finance Minister is personally willing to call the conference and that all probability of its being held in Tokyo has not disappeared.

Chief hope of calling a conference seems to lie with the Chinese government at Nanking, however, as India is not in a position to act independently of Great Britain, although her delegates were the most pronounced advocates of silver at the chamber meeting. The resolution adopted by the chamber follows:

"The International Chamber of Commerce, realizing the serious consequences of the present silver situation to the economic condition of the world, considers the convocation, during the current year, of a conference at which all interested bodies may be heard, for the purpose of seeking a solution to the problem, to be eminently desirable, and urges the national committees to bring the matter to the attention of their respective governments."

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Calumet & Hecla Working Four Drills in Keweenaw County

Calumet & Hecla has four drills at work in Keweenaw County, Mich., in continuation of the searth for a major lode, believed to be the source of the copper in the fissure lodes. Three holes are going down from surface and one hole is being drilled from the bottom of the Phoenix shaft. A cross fissure, southeast of the old Central mine, and the Kearsarge conglomerate horizon are being explored further. The fissure vein, although it shows some copper, is important only as a guide to lode mineralization. In the Kearsarge conglomerate horizon, mineralization was found by previous drilling in a small area southeast of Phoenix.

Success in the Keweenaw County exploration depends largely on the drilling campaign and further investigation in the Phoenix shaft, which is being sunk to allow opening work at a depth of 1,000 ft. vertically below the No. 16 level. Depth appears to be the key to the search, as it has been established that the hypothetical major lode is not mineralized at the elevation of the bottom levels of the old fissure mines. In diamond drilling, presence of copper in the cores is not conclusive and must be followed by underground opening work to establish continuity of commercial copper.

A new type of bit used in diamond drilling by the Sullivan Machinery Company of Chicago, which has the contract for Calumet & Hecla drilling, is reported to have increased drilling efficiency and lowered costs. Bort is being used instead of black diamonds, heretofore employed. Use of the new cutting element may result in more drilling than has been possible heretofore. Footage drilled daily has been increased largely since bort has been used.

To reduce costs, Calumet & Hecla has closed No. 14 shaft in its Osceola lode department. This leaves three operating shafts on the Osceola lode. Ground in No. 14 was quite low grade. No. 16 was shut down last fall, Nos. 13, 15, and 17 are in commission.

Three Coeur d'Alene Mines Close as Lead Drops

Three Coeur d'Alene mines have suspended all production and a fourth is curtailing output as a result of the continued drop in the price of lead, now 3.75c. a pound. The mines that have stopped producing are the Sherman, Dayrock, and Golconda, and the one to curtail is the Jack Waite. As a result of these decisions, the number of producing mines in the district is now down to seven—Bunker Hill, Hecla, Morning, Page, Sunshine, Jack Waite, and the Mutual Mines property, which recently started a new concentrator and is shipping its lead concentrate by truck to the Bunker Hill smelter.

Suspension at the Sherman and Dayrock mines, both controlled by the Day interests, is understood to be complete, only watchmen being retained. About 55 men had been employed at the two mines, prior to suspension. Each shipped six or seven carloads of ore a week to the Hercules custom mill (capacity 1,000 short tons daily), which is now also forced to close down. In 1930, Sherman produced 29,847 tons of ore, containing 3,154 tons of lead and 210,848 oz. of silver, compared with a 1929 output of 49,624 tons of ore, 4,640 tons of lead, and 225,199 oz. of silver. Dayrock production for the last two years has been: 1930, 29,987 tons of ore, 3,221 tons of lead, and 262,948 oz. of silver; 1929, 37,254 tons of ore, 3,776 tons of lead, and 293,721 oz. of silver.

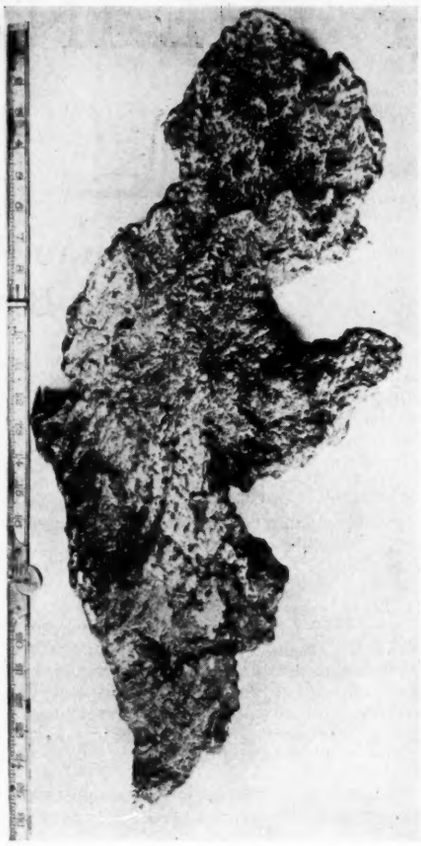
Golconda has been on a development basis for a long time and has been operating its mill on a one- or two-shift basis, depending on the amount of ore available from development. Production in 1930 was only 21,065 tons of ore, compared with 65,969 tons in 1929 (for development details see "Brief Notes," p. 483). Jack Waite started operation of its new 500-ton mill in February, and had been operating at near capacity until the beginning of May, in addition to shipping some high-grade ore. About 50 men have been laid off, leaving a little more than that number on the payroll.

Effective May 16, the three leading companies in the district—Hecla, Bunker Hill, and Federal M. & S. (which operates both the Morning and Page mines)—announced a wage cut of 25c. a shift. A similar cut has recently been made at Utah lead mines. The reduction in the Coeur d'Alene district brings the bonus payment now in effect down to $1 a shift, although the sliding scale agreement provides for no bonus when the lead price falls below 5½c. per pound. The wage level in effect after the cut is $4.75 per shift for miners, and $4.25 for muckers and millmen.

■

Big Hill-North Lily Connected

The North Lily and Big Hill mines, in the East Tintic district, of Utah, have been connected. North Lily controls Big Hill through the North Lily-Knight Company. A drift from the 1,200 level of the North Lily shaft has been completed to the 1,700 level of the Big Hill shaft. Sinking of the latter to the Ophir formation is now under way. In making the connection, several strongly mineralized fissures were struck. These will be prospected in Eureka Bullion ground, operated under lease by North Lily-Knight.



Although this nugget, weighing 1,135 oz. and discovered in Western Australia in January, has been called the "Golden Eagle," the editor thinks that it might more appropriately have been called the "Golden Baby"

Lucky Tiger Reserves Drop With Price of Silver

On Dec. 31, 1930, ore reserves at the property of Lucky Tiger-Combination, in northern Sonora, Mexico, were only 23,885 short tons, assaying 0.06 oz. of gold and 38.8 oz. of silver per ton, a decrease of 46,636 tons from reserves at the end of 1929. The drop in the price of silver has eliminated at least 19,300 additional tons, assaying between 20 and 30 oz. of silver per ton, which cannot be considered ore at present prices. Development work for the year totaled 8,168 ft., of which only 10.2 per cent was driven in ore. The greater part of the exploration program outlined by Guy N. Bjorge, of San Francisco, was completed without discovering any new orebodies, according to R. T. Mishler, general manager of the company. Near the north face of No. 14 level, a crosscut driven east encountered indications of ore, but a large water flow, now being drained, prevented further exploration.

A considerable decrease in operating costs at the property has been effected, in spite of the fact that the tonnage handled was smaller than in 1929 (47,068 tons, compared with 61,362 in 1929). Costs averaged $16.72 per ton, compared with $18.89. Cost per ounce of silver produced dropped from 42c. per ounce to 39c., and is now about 29c.

On account of declining production and silver prices, the company decided early in 1930 to request permission, in accord with Mexican law, to reduce personnel and wages. The permission was granted and put into effect the middle of the year. Later it was decided best to close down and effect a complete reorganization. Request to close down was filed during October and granted the middle of February, 1931. Since then, arrangements have been made to operate with reduced personnel, wages, and taxes, under the supervision of the governor of the state. Under these conditions, and a reduced development program, it should be possible to operate with silver as low as 25c. per ounce.

■

Santa Maria Property Working Under New Agreement

After having been suspended for the second time since the beginning of 1931, operations have again been resumed at the Santa Maria de la Paz silver property, in the Matehuala district of Mexico. A new agreement has been drawn up, embracing the owners of the property, the workers, and the government. The terms of this agreement are not available. As a result there is considerable doubt as to how long the operation of this property, the largest silver producer in the district, will continue. Suspensions have been caused by the drop in the price of silver and by the failure of the workers and the operators to reach an agreement. In fact, one attempt was made to have the property operated by the workers themselves. The employment situation in the district is acute, because of the closing down of the Dolores mine of American Smelting & Refining, and the government is anxious to have the La Paz continue in operation as long as possible.

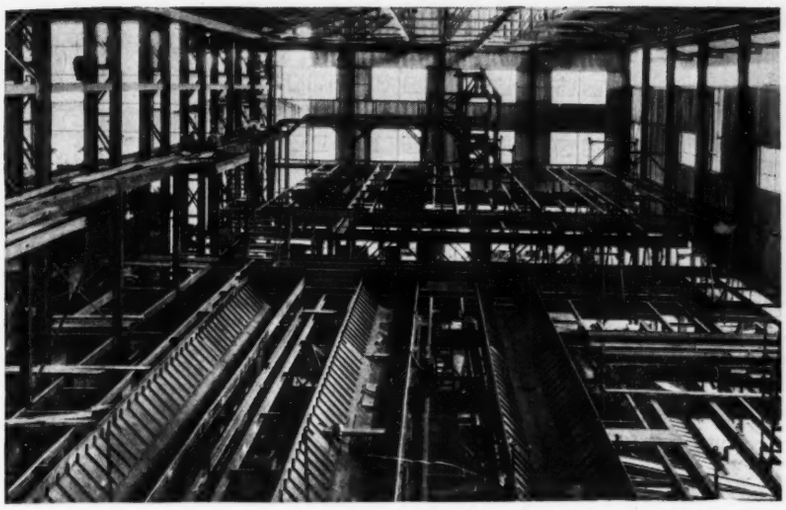
Reports that the Matehuala smelter of A. S. & R. had closed down on May 10 are incorrect, according to an official statement obtained from the company's New York office on May 19. The smelter will continue working as long as the La Paz mine is in operation, as it is now almost entirely dependent on that property for its ore supply. The Kildun mine, in the same district, is shipping to the San Luis Potosi smelter.

■

Combined Metals Curtails

Operation of the flotation plant of Combined Metals, at Bauer, Utah, is being put on a half-time basis until prices of metals improve. The plant treats lead-zinc-silver ores from the company's own mines at Stockton, Utah, and Pioche, Nev., in addition to some custom material. According to the present plans, the mill will be operated every other month, E. H. Snyder, the general manager, states. This plan, the company believes, will insure lower costs and higher efficiency and make employees' off-time more useful.

Shipments from the Combined Metals mine at Pioche have been stopped. The Bristol property, at Jackrabbit, near Pioche, which Combined Metals controls, will discontinue shipments about the first of June. Development work will be continued at the Combined Metals and Pan American mines. Work at these properties has developed, within the last year, a large orebody averaging 18 per cent zinc, 8 per cent lead, and 8 oz. of silver per ton. St. Louis Smelting & Refining, mining subsidiary of National Lead, has a large interest in Combined Metals.



The flotation bay of the new Roan Antelope concentrator in Northern Rhodesia, which is expected to start soon

End of Elkoro Operations in Sight, Report States

Elkoro Mines, one of the two largest gold producers in Nevada in 1930, will have exhausted its known orebodies at Jarbidge, Nev., by the end of 1931, according to S. W. Howland, president of Yukon Gold. The company has been engaged in an active development campaign for several years but has failed to find new orebodies. This work is being actively continued. Elkoro Mines is controlled by Yukon Gold, which, at the end of 1930, held $1,427,054 in the company's notes (plus interest). About 150 short tons, averaging $10 in gold per ton, is being handled daily at the property. Production at the property was started in 1918, and has averaged better than $500,000 annually since then.

Of the other Yukon Gold operations, the Sadie claim of Keno Hill, Ltd., which Treadwell Yukon has been working under lease, has been exhausted of ore that can be treated profitably at present metal prices. On the Porcupine claim, a new vein has been developed, averaging 4 to 7 ft. in width. Work on this deposit has been suspended, pending improvement in metal prices. Malay States Tin has acquired two new tin-dredging properties—Kinta Bahru and Gombak. The former is estimated to carry 18,000,000 cu.yd. averaging 0.65 lb. of 73 per cent tin concentrate per ton and the latter to carry about the same yardage averaging 0.79 lb. of concentrate per ton. Suitable dredges are now being designed, but equipment will be postponed in view of low tin prices.

■

Start Two Holes at Globe

Two more diamond-drill holes are being started in Globe lands, near Painesdale, Mich., by the Longyear Exploration Company, which has the contract for Copper Range drilling. A fair showing of copper already has been revealed in two holes in both the Baltic and West lodes, and a good showing in a third hole. The two new holes will be put down each side of the hole with the best grade. Ground also is being opened at depth in a drift south from Champion.

Sutro Tunnel Drifting North Along New Orebody

Development is being continued along the new orebody developed in the Crown Point mine, on the Comstock Lode, in Nevada, in a northerly direction toward the Yellow Jacket shaft, according to D. C. Catlin, a director of Comstock Tunnel & Drainage. This company owns Sutro Tunnel Coalition Mines (not Sutro Tunnel Corporation, as was incorrectly stated in the issue of May 11), the operating company. The grade of in gold and silver per ton and the width of the ore is about 60 ft.

According to Mr. Catlin, the crosscuts driven on the winze levels have shown ore varying from 40 to 60 ft. in width. Assays of the ore indicate that the value of the gold content is about twice that of the silver content at present silver prices. Development has been undertaken through two tunnels, of which the upper is 50 ft. from the surface at the point where it cut the vein. (Our earlier report stated 125 ft.) The second tunnel is 100 ft. lower and the winze is down an additional 100 ft., making total depth only 250 ft.

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Con. Coppermines Costs

In the issue of May 11, on p. 430, reference was made to the discussion concerning the cost of producing copper at Consolidated Coppermines, operating properties in the Ely district of Nevada. This discussion, which occurred at the company's annual meeting in New York, was largely between J. B. Cotton, director and counsel of Coppermines, and R. D. Hoffman, mining engineer. In this connection, the company points out that a book figure of 11.527c. per pound for operating expenses includes write-offs of prior development, but takes no account of credits for precious metals. When these items are deducted, the net direct operating costs for the year, before development write-offs, is 8.886c. per pound, as shown by the annual report. Similarly computed, costs for the company's Emma-Nevada mine (its main producer) during the six months ended March have been below 7.5c. per pound of copper.

Patent Issue May Arise Out of Methane Zinc Process

Under the recent decision of the U. S. District Court for Delaware, in the so-called Dubilier case, Charles G. Maier, metallurgist of the U. S. Bureau of Mines, can retain all right, title, and interest in any patents that may be granted relating to his discovery of a methane process of zinc reduction. Although the use of methane is not new, it is anticipated that Mr. Maier can protect his discovery by establishing his claims to particular features of the process, such, for example, as the low range of temperatures employed or, perhaps, the use of light metal alloy retorts instead of the clay retorts used in present smelting practice. That reduction can be accomplished at temperatures below 1,000 deg. C. is regarded as a vital feature of the Maier process.

In Washington the understanding is that Mr. Maier, who is attached to the Pacific Coast Experiment Station of the Bureau, at Berkeley, Calif., intends to apply for patents. In the event that such patents are issued, the government will retain only the shop rights unless it is successful in overturning District Judge Nields' decision and initiates and establishes a case against Mr. Maier. Because of the fundamental importance of the issue involved, the government will appeal from the Dubilier decision, which confirmed the title of Francis W. Dunmore and Percival D. Lowell, employees of the Bureau of Standards, to patents covering the use of ordinary house-lighting alternating current in the operation of radio receiving sets. The court's decision in this case is regarded as controlling in the case of Mr. Maier's invention because he, like the two radio research experts, was not working on the problem which culminated in the invention, by specific instruction of a superior. In dismissing the government's claim to title in the radio patents, Judge Nields held that by exercising their skill, knowledge and experience, the two employees fully performed the duties owing to the Bureau of Standards within the field of work assigned to them. For an employee to go beyond such skill, invoke his inventive genius, and make a patentable invention, said the court, is the unusual and abnormal thing, not the incident to his general employment. In cases where government employees are definitely assigned to inventive work, such as the potash recovery studies of the Bureau of Mines, it is stipulated that they assign all inventions to the public. No employee, however, is required to enter upon such work.

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Searchlight District Active

A group of California mining men has undertaken the reopening of the Duncan property in El Dorado Canyon near Searchlight, Nev., under the name of the United Exploration Company. E. T. Green is president of the company. Recently, the El Dorado Empire property in the same district, C. E. L. Gresh, manager, reported an important discovery. At Searchlight, the old Duplex property, under W. J. Loring, is being operated again. This mining area, close to the California line, has been inactive for several years, except for occasional leasing.

United Verde Smelter Down; Development Continued

Operation of the smelter of United Verde Copper, at Clarkdale, Ariz., was suspended on May 21, and only a skeleton force remains at work in the plant. Development work is being continued at the mine at Jerome, and such ore as is removed will be stockpiled for treatment at a future date. No reduction is being made in the number of men employed at Jerome, according to W. V. DeCamp, general manager of the company.

Suspension of production by United Verde is the result partly of the copper market and the large surplus stocks of metal held by the company and partly of a slide of waste rock in the open pit, which occurred in April. United Verde produced a greater tonnage of copper than any other mine in Arizona in 1929, when its output was 71,165 short tons. Figures for 1930 are not available, but production was about 50 per cent of the 1929 total. At the beginning of 1931, the rate of output was about 2,500 tons of copper monthly, with two furnaces in operation. When the slide occurred in April, one of the reverberatories was shut down. At that time, official statement was made that operation of the remaining reverberatory might be discontinued in the near future.

The work at Jerome will include removal of the waste from the steam-shovel pit and the establishment of new steam-shovel benches. Also, the mining of underground ore from pillars will continue, and this ore will be stockpiled for future use. Sinking of the new No. 7 shaft, to replace the present main hoisting shafts (which have been affected by earth movements), will also be continued.

No information is available at present as to when production of copper will be resumed, Mr. DeCamp stated in his official announcement of suspension. "The price of the metal at present is very unattractive and there is little indication of an increase in the near future," he added. Figures on the cost of production of United Verde are not published, as it is a privately owned corporation. Such estimates as have appeared in the past indicate that it is relatively lower cost than most of the other Arizona mines.

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Magma to Close June 12

Magma Copper, operating at Superior, Ariz., will suspend operations for a period of six weeks, starting June 12. Last year, the mine, mill, and smelter were closed down for a month during the summer. This suspension permits the company to curtail output considerably and yet to handle a sufficient tonnage, while in production, to keep costs at a minimum. In addition, it affords a vacation for all employees. During the first quarter of 1931, copper production was about 1,200 tons monthly, indicating that the shutdown will cut annual production by about 2,000 tons.

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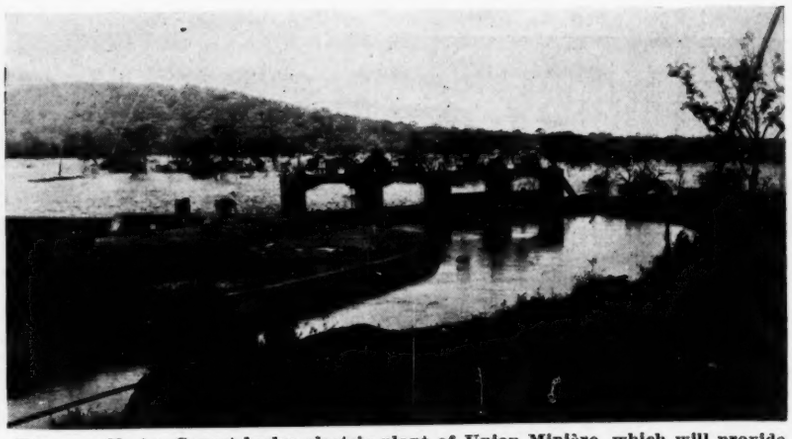
General Wage Cut in Utah

Wages in Utah metal-mining camps have been cut 25c. a day, according to dispatches from Salt Lake City. This wage reduction applies only to companies operating underground properties. No word has yet been received that either Utah Copper, the largest operator in the state, or the smelters have made a cut, although the possibility of similar action by the latter has been mentioned. At Utah Copper, nearly all men are on a part-time basis already and are probably not averaging more than 60 per cent of normal earnings. The cut at the underground mines reduces pay for machine work to a range of $4 to $5 daily and for shovelers to a range of $3.25 to $4.25. Several Utah mines had already made cuts below the level provided in the sliding-scale agreements. These, as a rule, change the rate of pay only when lead rises above 6c. a pound.



The new Chutes Cornet hydro-electric plant of Union Minière, which will provide 45,000 hp. for electrification of mining operations in the Belgian Congo

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Arizona Conference Votes for Tariff on Copper

Prominent men from all sections of Arizona met in Phoenix on May 11 at a conference called by Governor G. W. P. Hunt to consider the crisis being faced by the state as a result of the present low price of copper. The conference went on record as favoring a tariff on copper, and the Governor announced that he would appoint a copper tariff commission "to officially represent Arizona in the gathering of data and information to prove that the copper-mining industry must be protected from destruction."

Congressman Lewis W. Douglas was present and told the conferees that it is very difficult to secure a special act of Congress placing a tariff on one or two articles, although it has been done. The important thing, he said, was to devise ways and means of obtaining accurate information on the subject of a copper tariff. Senator Carl Hayden described the required mechanics of obtaining a tariff and said that no one, at the last session of Congress, had taken the essential step of appearing before any of the committees to ask for a copper tariff.

Several other speakers told of the bad effects throughout the state of curtailments at the various copper mines. Among the speakers were Governor Hunt; Charles F. Willis, editor of the Arizona *Mining Journal;* and Dr. Nelson D. Brayton, of Miami. Hugo B. Farmer, chairman of the Arizona State Senate committee on agriculture and forestry, and A. A. Johns, president of the Arizona Wool Growers' Association, pledged the support of their organizations in the movement for a tariff on the red metal.

Development at Cerro Mines Adds Ore at Depth

Development at depth at the properties of Cerro de Pasco Copper in its Cerro de Pasco unit, north of Oroya, Department of Junin, Peru, has opened new orebodies of good-grade ore at greater depths than had previously been mined, E. H. Clark, president of the company, stated at its annual meeting on May 13. The Cerro de Pasco unit produces copper-silver ore, which is treated at Oroya. No indication was given at the meeting of the grade or extent of the new ore, but a new set of shafts will be put down to permit exploitation. At present four two-compartment shafts and one main shaft are used. Reserves at all mines are satisfactory, and costs are probably as low as can be effected with curtailment.

Mr. Clark stated that the company had spent $1,000,000 on construction so far this year and that it will take another $1,000,000 to complete construction work under way. The company has discontinued all expenditures it could on the power and other projects where it would not entail loss to the company on work already started. Most of the work now in progress will be completed by September. It will take about one and one-half years after that to complete the power project. The Mahr tunnel to drain and develop the Morococha copper mines is being continued and will take about four years to complete. Progress is at the rate of about 700 to 750 ft. a month.

Mr. Clark explained that the 25,000 hp. of hydro-electric power which the company already has available is sufficient to meet requirements at present curtailed rate of operation. Consequently, there is no immediate need for the 35,000 to 40,000 hp. which will be developed by the Montaro project.

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California Kills Cassidy Bill

Although the California legislative stage was set for the slipping through of the Cassidy bill, which had passed the Senate, the Assembly Mines and Mining Committee killed the bill. The Cassidy bill provided for the exemption of the issuance and sales of mining stock from the provisions of the State Corporation Securities Act, or "Blue-sky" law. Apparently, the Cassidy bill was slated to go through, but opposition developed at the last minute, and the bill was killed in committee.

Mine Safety Competition Results Announced

The remarkable growth of the safety movement in the mining and allied industries is again demonstrated by the awards made to a large number of mines and quarries participating in the National Safety Competition for 1930 in recognition of the long-time operation of their properties with no accidents or with decidedly low accident rates. The National Satety Competition is conducted annually by the U. S. Bureau of Mines. In letters addressed to the companies receiving trophies and to those given honorable mention, Scott Turner, Director of the Bureau, states that an increasing number of companies are succeeding in operating their properties with unusually favorable records in accident prevention. The National Safety Competition, he says, is proving an effective safety movement largely because its competitive features have a strong appeal both to mining companies and their employees.

More than 300 large operations participated in the competition during 1930. Of these, 72 went through the year without a single lost-time accident. Contestants were divided into five groups, underground anthracite, bituminous coal, metallic ore, and non-metallic mines and quarries or open-cut mines. A replica of the bronze trophy, "The Sentinels of Safety," donated by the *Explosives Engineer,* was awarded the winner in each group.

The trophy winner in the metal-mine group was the West Vulcan iron mine, of Penn Iron Mining, Vulcan, Mich., which worked 318,402 man-hours without a lost-time accident.

Honorable mention in the metal-mine group was given to the Berkshire iron mine of Brule Mining, Stambaugh, Mich., working 283,807 man-hours with no accidents; the Wilbur zinc-lead mine of Commerce Mining & Royalty, Cherokee County, Kan., working 217,080 hours with no accidents; the James iron mine of James Mining, Iron River, Mich., working 157,891 hours without an accident; the West Side zinc-lead mine, of Commerce Mining & Royalty, Cherokee County, Kan., working 146,066 hours with no accidents; and to the Scammon Hill zinc-lead mine of Commerce Mining & Royalty, Commerce, Okla., which worked 122,701 hours without an accident.

In the non-metallic mine group, the trophy was awarded to the Lower gypsum mine of U. S. Gypsum, Gypsum, Ohio, which worked 108,090 man-hours without a single lost-time accident.

Honorable mention in this group was given to the Wampum limestone mine of Crescent Portland Cement, Wampum, Pa., which worked 100,687 man-hours without a lost-time accident; the Akron gypsum mine of Universal Gypsum & Lime, Akron, N. Y., working 64,647 hours with no accidents; the Retsof rock salt mine of Retsof Mining, Retsof, N. Y., working 307,214 hours with but 1 accident causing 55 days of disability; and to the No. 6 gypsum mine of U. S. Gypsum, Plasterco, Va., which worked 151,401 hours with 3 accidents causing 62 days' disability.

The winner in the quarry and open-cut mine group was the Plymouth iron mine of Plymouth Mining, Wakefield, Mich., which worked 382,541 man-hours without a lost-time accident.

No national or international first-aid and mine rescue contest will be held in 1931. Mr. Turner announced the decision to forego the contest this year was influenced by several considerations, not the least of which is the fact that the method of financing these gatherings has not been satisfactory. By next year the hope is that provision may be made whereby in the future the Bureau can finance such events adequately.

Since the Bureau came into existence in 1910, one of its numerous functions has been the sponsoring of national or international first-aid and mine rescue contests. These contests bring together about 50 first-aid and 15 mine rescue teams from 15 or more states. In some years, teams from Mexico and Canada have participated. The teams chosen are usually the winners of company, district, or state contests, and the trip to the national or international meet is a reward for expertness in first-aid or mine rescue work.

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Reopen Elko Prince Gold Mine, in Gold Circle District

The old Elko Prince mine, at Gold Circle, Nev., will be unwatered and the main shaft will be deepened from 750 to 1,000 ft. This mine has been closed down since 1922, when the mill and power plant were destroyed by fire. At that time, a winze had been sunk 150 ft. from the 750 level, following high-grade gold ore, 16 in. wide. It was put down about 1,400 ft. from the main shaft. Short drifts driven along the vein from the winze at the 150-ft. point disclosed the same grade of ore.

At present the mine is flooded to a few feet above 600 ft. Senator Noble Getchell, president and general manager of Gold Circle Consolidated, which now controls Elko Prince, announces that he has placed orders for pumping equipment in San Francisco and that he has also ordered an electric hoist, to be installed on the 750 level, and an air compressor of 650-cu.ft. capacity. A power line has been extended to the Elko Prince from the Gold Circle Consolidated power plant at the Grant mine, about a mile away. The power plant includes one 240-hp. and one 120-hp. Diesel engine, direct-connected with electric generators.

A 75-ton cyanide mill is also available at the Grant mine to treat ore from the Elko Prince. Production of the latter property is stated to have been $2,500,000, most of it coming from what was known as the south orebody. The new development work will probably be centered on the north orebody, however. Delivery of pumping equipment is expected within three weeks.

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New Shaft, Higher Tonnage at Wright-Hargreaves

A new central shaft will be sunk at the Wright-Hargreaves gold property, in the Kirkland Lake district, Ontario, to facilitate ore hoisting and development at this property. The shaft will be equipped to go to 4,000 ft., as compared with the present depth of 2,900 ft. of the south shaft, and will be put down midway between the two present shafts on the property. In addition, the company will probably raise its mill tonnage from 700 to 800 tons of ore daily. This is about the maximum capacity of present plant.

Crushing equipment at the new shaft may have as high a capacity as 1,500 tons daily. The precise size or capacity of the shaft itself is not yet known, although the *Northern Miner* states that when the shaft is completed, in about two years, Wright-Hargreaves will have shaft capacity comparable to Lake Shore and Teck-Hughes. In the meanwhile, five new levels are being opened up through the present shafts between 2,400 and 3,000 ft.

Production at the adjoining Lake Shore mine continues to run about $700,000 a month, with recovery averaging $12 to $13 in gold a ton. No. 3 shaft is now practically completed to 3,000 ft. and in a short time exploration work on several new levels will be started.

With the 350-ton addition to the Teck-Hughes mill now in regular operation, production has increased to about $600,000 a month. The company is negotiating for the Minaker property lying to the south of Lake Shore and west of Teck-Hughes.

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Oriental Cons. Reserves Drop; Mill Recovery Improves

After milling 208,366 short tons of ore during 1930, worth $1,251,229, the reserves of ore of Oriental Consolidated, operating a gold property in the Unsan district of Chosen, Japanese Empire, show a decrease of 45,000 tons and $280,090 in value. On Dec. 31, 1930, reserves were 320,000 tons, having a gross value of $1,700,000. One of the most favorable factors of 1930 operation was the improvement in the net recovery of gold from 79.2 per cent, the average in 1929, to 82.9 per cent in 1930. Installation of an Edwards roasting furnace, largely for treatment of oxidized material, has been a partial success, but, because of the fumes, probably the unit will be run during winter months only, according to J. B. Lower, general manager of the company. A plant for re-treatment of tailing dumps may be constructed during 1931, but otherwise the company does not expect to undertake any large construction program this year.

In the so-called "new mine" section of the Tabowie property, development during 1930 was satisfactory. Except for the Nos. 19 and 20 levels, new ore developed was largely in faulted ground, making accurate tonnage estimates difficult and indicating that actual production is likely to be considerably higher than the amount estimated. Sinking of a winze is under way, and Nos. 21 and 22 levels will be opened. Shortage of power, because of light rainfalls, is hampering development. In the Taracol mine, development will be centered on the area between the Nos. 15 and 18 levels. In addition, No. 11 level will be driven east and north on the main vein to explore a faulted section. In the Chintui mine, which has only 10,000 tons of $4.50 ore blocked out, prospects for additional ore are considered good. Sinking of a shaft to investigate ore below No. 13 level has been started. On that level, 300 ft. of ore showed an average width of 3 ft. and a grade of $15 a ton.

Fresnillo Depth Development Proves Ore Continuation

Completion of the Saraos and East shafts to the 560-m. level, followed by crosscutting to the east and west oreshoots, has proved that the Fresnillo sulphide deposits at Fresnillo, Zacatecas, Mexico, continue to carry better than average widths and grades at depth. Ore has been followed for 112 ft. along the West oreshoot from the Saraos shaft and for 95 ft. along the East oreshoot from the East shaft. On the 425-m. level, the deepest fully developed level in the mine, the East oreshoot was 1,102 ft. long and the West oreshoot was 1,876 ft. long.

Additional lateral development is being undertaken on the 470-m. and 515-m. levels from the East shaft, with equally good results. In fact, the 814 ft. of drifting done at 470 m. on the East oreshoot has indicated an average grade of 12 per cent lead, 17.5 per cent zinc, 0.8 per cent copper, and 12.2 oz. of silver per ton, which is considerably higher than the mine average. The width is 4.2 ft., compared with 3.2 ft. on the 425-m. level. Furthermore. the face of the drift is now in even higher grade ore.

In addition to this work, four winzes are being sunk and three raises are being put up in the area between 425 and 570 m. These will considerably improve the ventilation and facilitate development. Sinking has been resumed in the General shaft to provide for operation of skips to the 425-m. level. The cage compartment has been in use to that level for some time. The drop in metal prices has nearly extinguished the margin of profit at Fresnillo, but production is being maintained.

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Gold Metals Changes Hands

W. A. Rudgear and associates, including two Hollywood moving-picture producers, has taken over the Gold Metals mine, at Manhattan, Nev. The company will be reincorporated as the Gold Metals Consolidated Mines. A fund of $50,000 has been subscribed for development work and a cyanide mill. The mine is now opened to 150 ft. The property was first developed by the Sullivan brothers, of Manhattan. In April, 1930, Homer Black secured control. He enlarged the prospect shaft and installed a hoist and an air compressor. A power line, 2,000 ft. long, tapped the power line to Tybo. Under Black's management the shaft was sent from 75 to 150 ft. Heavy water flow called for installation of pumps. This condition, and an overhead of $22 a ton for trucking to Tonopah, compelled Black to shut down and seek capital for mill at the property. The War Eagle mill, in the same district, employs amalgamation, but Gold Metals ore responds more freely to cyanidation.

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Teziutlan Recovering Lead

An increase in lead content of the ore treated in the concentrator of Mexican Corporation at its Teziutlan unit, Puebla, Mexico, made advisable a further separation of the ore into three products: lead, copper, and zinc concentrates. Formerly only copper and zinc concentrates were produced. The change has now been accomplished. Average lead content of the ore is about 2.3 per cent and, in view of the unusually high lead content of the new Minerva orebody, now under development, it is likely to increase. About half of the 6,000 tons handled monthly is coming from development work on the Minerva orebody.

■

Montana Power Acquires Gas Line to Butte

Montana Power Company has purchased the Louis B. O'Neill interests in the Cut Bank gas field and the pipe line to Butte, Anaconda, Helena, and Deer Lodge, Mont. Work will start on this pipe line about June 1, and it should be completed by Oct. 15. Montana Power also purchased the pipe line of the Ohio Oil Company from Dry Creek to Bozeman and will supply several towns in central Montana from this line. About 3,500 men will be employed on the two pipe lines and distributing systems in the various cities.

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Report Riots for Food in Bolivian Mining Area

Insistent reports have been heard for three days that unemployed tin miners, in the important mining center of Oruro, Bolivia, attacked stores to obtain food, according to a cabled dispatch from La Paz, published in the New York *Times* of May 19. Troops were called to restore order, several casualties resulting from the clashes. Newspapers published varying accounts of the trouble, but the government has not yet confirmed the reports.

Tin is Bolivia's most important product, and the drop in price of the metal, with the consequent unemployment, has been the country's most serious problem for the last eighteen months. As an indication of the extent of curtailment, even before the new quota scheme went into effect in March, shipments of *barilla* or tin concentrate from West Coast ports during February and January, 1931, totaled 8,424 metric tons. In the same months of 1930, shipments totaled 13,572 tons. According to the new agreement, drawn up at The Hague during the last week, Bolivia's tin quota is about 28,000 metric tons of fine tin, compared with normal production of more than 40,000.

Our La Paz correspondent, in a letter dated April 10, writes: "More and more of the smaller tin mines are closing down company operations, and allowing contractors to work over old dumps and worked-out portions of the mines. It is reported that Morocacala is now producing around 4,000 quintals of *barilla* per month in this manner, at a small profit. This is almost as much as the company produced during the best days of straight company operation. In the Fabulosa group, the Milluni property is now producing over 1,000 quintals per month in the same manner; and the Union property will soon be changed to the same plan of operation. At the Fabulosa property, one of the few mines in Bolivia where the ore occurs in mineralized pegmatite dikes, some unusually rich orebodies have recently been opened up on the lowest levels. All the larger mines are continuing with programs of restricted production. Probably none of them, with the possible exception of Aramayo Mines, are making any operating profit under present conditions."

Pachuca Orebodies Are Nearing Exhaustion, Engineer States

Because of "immoderate exploitation" for many years, and particularly during the last decade, mineral deposits in the Pachuca region, State of Hidalgo, Mexico, the world's largest silver-producing field, are rapidly nearing exhaustion, says Manuel Santillan, chief of the Section of Mineral and Metallic Deposits of the Geological Institute of Mexico, who has reported exhaustively to the Institute after a study of the zone.

"The Pachuca mineral zone has been exploited on a large scale for many years, especially during the last ten years—so much so that the virgin mineral deposits that could be found in future, within the perimeter of this mining district, will be only some 'blind' veins and others with outcrops of scant potentiality and mineralization," Santillan's report says in part. "These will contribute in but a small proportion toward increasing the mineral reserves that exist there, for these veins generally correspond to mineralized fractures of lesser development and potentiality than do the principal veins which have been exploited.

"The life of the Pachuca zone depends more upon the intensity with which the already known deposits are exploited, than from the number of new veins that it is possible to discover. The expectation that the veins thus far known offer in depth is null, for at about 525 to 550 m. below the surface (or, generally speaking, beneath 2,100 m. above sea level) there are none of commercial grade. Although the fractures contain quartz fillings, the mineralization is poor and weak.

"Ore in the richer sections of the veins results principally from the minerals of primary origin, and because of that, hopes for ore at depth must not be based upon the secondary enrichment."

Of the several companies that operated in the Pachuca district, only three companies are now producing there. They are: Real del Monte, San Rafael, and Santa Gertrudis.

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Further Beattie Drill Results

At the annual meeting of Ventures, Ltd., held in Toronto on May 18, reference was made to the drilling results on the Beattie gold property, at Duparquet Lake, in Quebec (see p. 433 of May 11 issue), in which Ventures holds about a 73 per cent interest. The first fifteen holes drilled indicated a deposit 104 ft. wide over a length of 1,200 ft., with average grade of slightly more than $3 per ton in gold. These holes cut the vein at depths of 300 to 400 ft. The second series of holes is now being drilled to a vertical depth of 500 ft.

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Arranges for Scossa Pilot Mill

E. M. Dawes, president of Dawes Gold Mines, operating at Scossa, Nev., has returned to the mine from Los Angeles and reports that he has arranged the financing of a pilot mill at the Scossa property. He will continue exploration on the 100 level and then sink another 100 ft. To date the 100 level shows milling ore with a 10-in. streak of high-grade ore in drifts sent out 40 ft. each way from the shaft. Discovery of the Scossa area last December created considerable excitement in Nevada.

BRIEF NOTES

B. C. Silver Prospects. The company has taken no steps toward equipping its property, in the Portland Canal district of British Columbia, for production, according to information made available at the annual meeting of Selukwe Gold, which controls the company, in London. B. C. Silver is believed to hold claims through which the continuation of the Premier silver-gold lode has been traced. Rather than incur the expense of building its own plant, the management prefers to negotiate with Premier Gold for treatment rights in the latter's mill. Previous efforts to reach an agreement have been unsuccessful. In the meantime, development is being continued, 1,937 ft. having been driven last year. A raise above the No. 6 level exposed high-grade ore for 50 ft.

Buffalo Mill Shipping. Two carloads of gold concentrate have been shipped from the flotation plant of the Buffalo mine, near Sumpter, Ore., since operation was started on May 4, according to Rowland King, engineer for Explorers, Inc., which has acquired an interest in the property. The lower tunnel level has recently cut into ore on the No. 3 vein, Mr. King added. Concentrate is shipped to the Bunker Hill smelter, at Kellogg, Idaho.

Callahan Zinc-Lead Drills. At its Galena property, near Wallace, Idaho, development is confined largely to diamond drilling of the two ore-bearing veins. Holes have been drilled on the 800, 1,000, and 1,200 levels and will be drilled at the 1,400 and 1,600 levels as well. On the 1,200 level, a crosscut was driven 135 ft. to ore. Drifting along it for a distance of 116 ft. disclosed widths of only 2 ft. or less, but the grade was as high as 20 per cent lead and 17 oz. of silver in places. Drilling on the 1,000 level indicated some ore in two holes, and crosscutting to determine its extent will be undertaken.

Cinnabar King Output Climbs. Production from the new plant that the company put into operation at its property, near Spring Valley, Nev., on April 28 has been increased to a basis of from 75 to 90 flasks of quicksilver a month. G. S. Clack, president and general manager of the company, has presented the Mackay School of Mines Museum, at Reno, Nev., with a 250-lb. specimen from the mine. It is said to be exceptionally high grade.

Dome Mines Grade Higher. Grade of ore handled at the property in April was $6.57 in gold per short ton, or more than 90c. higher than the March average of $5.66. April production totaled $296,680, and was the second highest month since operations were resumed in October, 1930. Development work is centering on the new ore disclosed at the No. 12 level. The mine is near Timmins, Ont.

Eldorado to Ship Radium Ore. A shipment of radium ore from the company's property at the east end of Great Bear Lake, Northwest Territory, is expected to be brought out "before next winter," according to a report issued by the Department of Mines, at Ottawa, Canada. The report states that the company's holdings constitute "the most important discovery of radium-bearing mineral yet made in Canada." Samples sent to the Mines Branch proved to be massive pitchblende, carrying up to 84 per cent uranium oxide, equivalent to 213 mg. of radium per ton. The samples are stated to have been taken from two veins which have been traced for several hundred feet and range from 2 to 6 in. in width. Should the season's work succeed in proving an adequate tonnage, Canada may soon produce radium commercially.

Federal M. & S. Deepens Shaft. The main shaft at the company's Page lead property, in the Coeur d'Alene district of Idaho, is being deepened from the 1,200 to the 1,500 level. A crosscut will be driven to the Tony vein, west of the shaft, at the latter level. About 700 ft. of crosscutting will be necessary to reach the vein, according to H. G. Washburn, general manager of the company. On the 1,200 level the oreshoot is 1,200 ft. wide and averages about 6 ft. in thickness. Average grade of ore mined at the Page in 1930 was 9.44 per cent lead, 2.46 per cent zinc, and 4.39 oz. of silver per ton. The mine is now on a five-day week, handling 300 tons daily.

Golconda Lead Strikes Ore. A diamond drill recently put down to the east of the fault on the 1,400 level of the mine, near Wallace, Idaho, showed ore, according to William Beaudry, general manager. Previous efforts to locate the oreshoot east of this fault had proved unsuccessful. A crosscut has now been driven to the ore and it has proved to be 3 ft. wide, carrying 15 per cent lead, as well as some silver and zinc. Drifting east on this orebody will also permit Golconda to fulfill its program for development of the adjoining Square Deal property, on half of the capital stock of which it has an option. The boundary line is about 600 ft. east of the fault. West of the fault, ore has been proved for about 800 ft. On the 1,000, or main tunnel, level of the mine, drifting is being started on the Mayflower vein to investigate the extension at depth of some intersting surface outcrops. All production has again been suspended at the Golconda and only a few men are being retained on development work.

H. & H. Mining Formed. The company has been incorporated in Missouri with a capital of $50,000 to operate lead-zinc properties. The incorporators are Harry H. Hawkins, S. C. Hawkins, and I. R. Lively. The company's office is at Neck City, Mo.

Hammon Copper in Trustee's Hands. Alfred C. Carr has been appointed trustee of the company, which operates a copper property near Kirkland, Ariz. About 60 local creditors have claims against the company amounting to $45,000, and in addition the W. C. Hammon interests are said to have claims of $180,000. The company was organized in 1930 to take over the property from Zonia Copper. A 600-ton leaching unit, first of three to have been erected, has been partly constructed. A low-grade copper oxide orebody has been developed.

Lucky Strike to Start Furnace. Operation of the furnace at the La Joya quicksilver property, near Oakville, Napa County, Calif., which the company recently acquired, will be resumed. New orebodies have been developed in the property, formerly owned by Acme Mines & Mill. The furnace, which has a daily capacity of 40 short tons, was put in operation in November, 1928.

Mexican Premier Adds Claims. Mexican Premier, through its operating subsidiary in Mexico, San Jose, has purchased a 51 per cent interest in the Independencia group of claims, in Nayarit, Mexico, within half a mile of the main line of the Southern Pacific railroad. In addition, the company has denounced an adjoining claim, covering the extension of the veins for 3,280 ft. Negotiations are under way to obtain the remaining 49 per cent interest in the property. Sampling of the property has indicated an oreshoot 3 to 7 ft. wide averaging better than $10 in gold and silver per ton, according to H. W. Fairbanks, secretary of the company. Additional financing of the property will be necessary to continue development work.

Moscow Mines Ships. Occasional shipments of silver ore are being made from the property, in the Star district, near Milford, Utah. This ore is being taken from the Glory fissure, near the Fault stope. An oreshoot has been opened here and is being followed toward the limestone beds.

Nevada Con. Tonnage Down. During the first quarter of 1931, the average tonnage treated daily in the company's plants at McGill, Nev., Hurley, N. M., and Ray, Ariz., was only 17,459 tons, compared with 19,230 tons treated during the last quarter of 1930. These figures do not include custom ore treated at the Nevada unit. The yield of copper per ton of ore dropped from 20.97 lb. per ton to 20.90 lb., but the actual recovery improved from 84.9 to 85.25 per cent. Costs, before depreciation or federal taxes, were 8.88c. per pound, compared with 8.96c. in the previous quarter.

Niagara Placer Formed. A group of Spokane men have incorporated the company in Idaho to operate a group of placer and lode claims in the southeastern section of Shoshone County, Idaho, within the drainage of the headwaters of the North fork of the Clearwater River. The property has been worked desultorily in the past.

Pacific Gold Obtains Mine. The company is operating the Ruby Consolidated Mines property, near Downieville, Calif. C. E. Gilman is in charge of the operations. The property consists of Tertiary river channels and was once an important drift gold mine.

Park City Cons. Drifting. East of the Silver vein intersection, at its property, near Park City, Utah, the company is drifting on the Roosevelt vein. On its 400 level, a drift to the south is following the Janney limestone formation. In April, the company shipped ore containing 81,702 oz. of silver and 65 oz. of gold. A total of 3,275 short tons of ore was mined during the month at an average cost of $3.11 per ton. The average grade was 25.94 oz. of silver per ton.

Rio Tinto Copper Formed. The company has been organized in Salt Lake City to develop properties in the Cope mining district of Elko County, Nev. Capitalization is $100,000. S. F. Hunt is president and general manager of the company.

Shan States Adds Ore. The limited development work done at the Bawzaing mine, near Kalaw, in southern Burma, during 1930 increased ore reserves to about 200,000 long tons of high-grade

(Continued on page 484)

EXCLUSIVE

CABLES

FROM CORRESPONDENTS IN THE PRINCIPAL MINING CENTERS

New Tin Scheme Recommended; Mount Isa Starting

London, May 19.—A meeting of representatives of the tin producers of the Federated Malay States, Bolivia, Nigeria, and the Dutch East Indies, held at The Hague, Netherlands, recommends further curtailment of output by 20,000 long tons annually. Evidently, the producers have realized that the scheme adopted in February, and since agreed to by all four countries concerned, will not be sufficient to halt the mounting stocks of metal. This additional curtailment makes the total curtailment 33 per cent of the 1929 production of the four countries, which was roughly 161,000 long tons. The first plan called for curtailment to 125,773 tons annually, and the new one asks a further reduction to 105,800 tons annually.

. . . . The quotas allotted the several countries are Malaya, 46,500 tons; Bolivia, 28,900 tons; Dutch East Indies, 23,400 tons; and Nigeria, 7,000 tons. These figures are for recoverable tin content of concentrate exported, or, if the country has a local smelting industry, for fine tin. Regulation is achieved through export quota by the local government, and the plan will be effective for two years. Opinions as to the efficacy of the new agreement are divided. F. E. Mair, one of the leading members of the Osborne-Chappel group of tin companies, suggests that a 50 per cent reduction in output would be necessary to make the arrangement effective unless consumption increases. The new plan will probably become effective on June 1 next.

. . . . A report from Mount Isa, the new lead-zinc enterprise in northern Queensland, states that the main shaft and ore pocket have been completed. Hoisting of ore was started through the shaft on May 1, and one section of the new 2,000-ton mill was started on May 11. It is stated to be running satisfactorily. The smelter is not ready yet and may not be in operation for some time. This property is expected to have an annual production of about 70,000 short tons of lead at the start, and, in view of its reserves of more than 30,000,000 tons of ore averaging about 8 per cent lead, of which all but 3,500,000 tons carries as much zinc, further additions to plant will undoubtedly be made when, and if, the lead market justifies. With quotations at present under £12 a ton for lead, however, this great mine is hardly choosing an auspicious moment for its start.

. . . . The quarterly report for Trepca Mines, the Jugoslavian lead-zinc mine that started operations last fall, is the first indication of the earning power of this new enterprise. Even with the depressed metal markets that have prevailed, the company reports gross revenue of £88,987 on sale of its lead and zinc concentrates during the first three months of 1930. Inasmuch as all costs, including London expenses, were £57,956, a profit of £31,031 is indicated. Production was 61,500 metric tons of ore. The official statement on the ore cut in the new deep-level adit (see *E.&M.J.* of April 27, p. 388) gives the width as 66 m., and the assay as 13.7 per cent lead and 7.9 per cent zinc. This level, 610 m. above sea level, is the lowest in the mine. Ore was cut 2,524 m. from the tunnel portal. On the 760-m. level, seven stopes have now been opened.

. . . . Of 558 ft. of new development work done by New Gold Fields of Venezuela, at its properties in the Bolivar district, 320 ft. was driven in ore averaging 14 dwt. in gold per ton over a width of 62 in., the monthly May report indicates.

. . . . Central Mining & Investment, mining finance house, reports a net profit of £483,926 in 1930, compared with £563,283 in 1929. However, the company has transferred £763,549 to its ordinary depreciation account, in view of the fall in share prices, and £1,140,000 to a special depreciation reserve in connection with Anglo-Spanish Construction, Ltd. As a result, the company's reserve fund has been drawn upon and has been reduced from £1,900,000 to £450,000. Anglo-American Corporation of South Africa has also transferred £1,000,000 from its reserve to meet the depreciation in the value of its interests in copper and diamond properties. No dividend will be declared.

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London Expecting News of Roan Antelope Start

London, May 21.—A cable announcing the starting of the new 5,000-ton plant of Roan Antelope Copper is expected here daily. [**Ed. Note**—According to the Dow-Jones ticker, in New York, the plant is not expected to be in operation until June or July. One authority has even stated that he does not believe it will start until the fall.] Capacity operation of the mill is expected to be reached early in 1932, at about which time the new smelter should be ready. In the meantime, the concentrate, averaging 60 per cent copper, will be sent either to England or to the Carteret plant of American Metal, in the United States, for treatment. Selection Trust obtained its option on the Roan properties in October, 1925. Prospecting began in May, 1926. The Roan Antelope company was formed in May, 1927. Since then, the railroad has been extended to the property, 108,000,000 tons of ore has been outlined by drilling, about 16 miles of underground workings have been driven, water supplies provided, a pilot plant has been erected and tested, and a modern plant of 5,000-ton daily capacity constructed.

. . . . Rhodesia Broken Hill Development produced 1,010 long tons of zinc and 15 long tons of vanadium in April. This compares with 1,335 tons of zinc and 23 tons of vanadium in March. The decrease resulted from combining the zinc and vanadium processes. Luiri Gold, Northern Rhodesia's other metal producer, reports a recovery of only £2,500 in gold from 1,618 tons of ore, compared with £2,517 from 1,705 tons in March. The yield at this property has been lower than expected.

. . . . A. D. Storke, managing director of Mufulira Copper, is expected to return from Rhodesia on May 25. Francis Cameron, geologist for Anaconda Copper, has recently returned from a trip to the copper district.

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Brief Notes

(Continued from page 483)

silver-lead ore. A new orebody was opened on the 330 level. In addition, geological work is being done on the adjoining Theingon area, which the company acquired last year. A mill with a capacity of 3,000 tons of ore monthly has been built, but it has not been put into operation because of the disturbed lead market, and the number of men employed has been cut.

Sunshine Mining to Drift. A pocket having been cut below the 1,700 level station at the property, in the Coeur d'Alene district, Idaho, drifting east and west of the point where the crosscut struck the vein is being started. According to John Sawbridge, president of the company, a minimum of 600 ft. of drifting in each direction will be undertaken. Both the Yankee Boy and the Sunshine or Polaris veins have been cut in the crosscut. Grade and widths are comparable to those obtained on the 1,300 level. Mr. Sawbridge also stated that, despite the low price of silver, "no curtailment in the slightest degree is planned." The company is now the largest producer of silver in Idaho, milling about 500 short tons daily. In 1930, 145,719 tons were extracted from the mine.

Tombstone Extension Reopens. Operations at the property at Tombstone, Ariz., were resumed on May 11 after a shutdown of several months because of low metal prices and litigation. About ten men are employed, but the number will be increased. Development work is now centered on the 250 level. The company plans to sink to the 400 level to explore the downward extension of known silver-lead ore deposits.

Tonopah Mining to Continue. The mine and mill of the company at Tonopah, Nev., will continue to operate as long as sufficient ore can be obtained under the leasing system to warrant the operation of the mill. The leasing system was put into operation last October, after the mine had been closed down for several months because of the low price of silver. None of the company's other properties are in operation, the Vertex mine and mill, near Silverton, Colo., having been closed down in November.

MARKET AND FINANCIAL NEWS

Stocks of Refined Copper Increased in April

Stocks of refined copper in the hands of North and South American producers on the last day of April amounted to 367,921 tons, an increase of 13,716 tons during the month. Stock of blister on April 30 totaled 193,876 tons, a reduction of 4,935 tons. Combined stocks of blister and refined registered a gain of 8,781 tons during April, according to the American Bureau of Metal Statistics.

Summary of Copper Statistics

In Tons of 2,000 Pounds

Production:	March	April
Mines, United States	48,702	46,883
Blister, North America (a)	71,244	65,509
Blister, South America (a)	24,551	24,613
Refined, No. & So. America	102,058	100,501
World, blister basis	136,655	.....
Stocks (end of month): No. and So. America:		
Blister (b)	198,811	193,876
Refined	354,205	367,921
Totals	553,016	561,797
Great Britain (c)		
Refined	9,887	12,784
Other forms	1,723	1,564
Totals	11,610	14,348
Havre	6,393	8,646

(a) Includes direct-cathode copper. (b) Includes in process. (c) Official warehouses only.

U. S. Mine Production

	March	April
Porphyry mines	18,575	18,514
Lake mines	4,531	5,229
Vein mines	22,037	19,740
Custom ores	3,559	(a) 3,400
Total crude production	48,702	46,883
Daily rate	1,571	1,563

(a) Partly estimated

Smelter Production

	March	April
United States	57,922	52,085
Canada	9,228	9,625
Mexico	4,094	3,799
Totals	71,244	65,509

Shipments

North and South America

	Export	Domestic	Total
1928	674,221	983,460	1,657,681
1929	586,594	1,119,409	1,706,003
1930			
January	30,358	69,932	100,290
February	29,597	61,879	91,476
March	30,523	73,644	104,167
April	29,196	50,017	79,213
May	49,115	75,760	124,875
June	44,818	71,887	116,705
July	42,466	75,436	117,902
August	38,319	56,810	95,129
September	37,873	65,169	103,042
October	38,246	75,703	113,949
November	45,051	62,693	107,744
December	39,169	69,854	109,023
Total	454,731	808,784	1,263,515
1931			
January	45,597	60,209	105,806
February	39,415	60,636	100,051
March	36,797	74,685	111,482
April	32,218	54,567	86,785

American Potash Profits

Net income of American Chemical & Potash, which operates a borax-potash property at Searles Lake, Calif., was $1,771,108 in 1930, compared with $1,348,428 in 1929. The company reported net sales of $4,149,280, and operating profits of $1,860,544 in 1930. The company's surplus on Dec. 31, 1930, was $3,882,593, compared with $2,729,954 at the beginning of the year. The balance sheet at the close of the year showed total assets of $13,346,385, of which $2,833,742 was current assets. Accounts payable were only $793,255. Dividends of $1 a year were paid in 1930, or $528,390.

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Lucky Tiger Shows 1930 Loss

Net loss in 1930, after all charges, suffered by Lucky Tiger-Combination Gold was $8,209, compared with $175,277 net profit in 1929. Value of production of its subsidiary silver-mining enterprise in Mexico, El Tigre, amounted to $767,129, on production of which an operating loss of $20,069 was realized, which, plus administrative expenses in the United States, brought the net operating loss up to $43,988. At the close of the year the company had total assets of $3,127,070, of which $1,333,950 was current assets. Of this, $410,047 is set aside in a special development fund. Production in 1930 was 47,084 short tons of ore. In addition, the El Favor unit of El Tigre Leasing, another subsidiary, treated 15,518 short tons before being closed down in June, 1930.

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Korean Mines Prosper

Oriental Consolidated, operating a group of gold mines in Chosen (Korea) Asia, increased its net profit, after all charges, from $420 in 1929 to $67,074 in 1930. Operating profit increased from $265,675 to $330,440. Production in 1930 had a gross value of $1,052,279, compared with $1,041,811 in 1929. On Dec. 31, 1930, the company showed total assets of $6,494,991, of which net surplus and reserves was $2,133,705. This compares with $2,017,960 at the end of 1929. Current liabilities at the end of 1930 were only $67,386. This compares with $250,580 in cash and $319,616 in amounts due the company.

Hollinger Net Profit Was Higher in 1930

In 1930, Hollinger Consolidated earned $3,963,728, after payment of depreciation and taxes, compared with the $3,638,606 earned in 1929. The increase was the result largely of increased production, gold and silver produced being valued at $10,263,505, compared with $9,433,767 in 1929. Other income, from the United States exchange premium and the interest on investments, was lower in 1930 than in 1929. Operating profit in 1930 was $4,373,031.

Despite an increase of $246,000 in dividend payments, Hollinger added $519,728 to its surplus, which stood at $11,629,888 at the end of the year, compared with $11,110,160 at the end of 1929. Current assets on Dec. 31, 1930, were $13,498,999 of total assets of $37,007,786. The company's investments are largely in International Bond & Share, a holding company. Current liabilities totaled $587,898 at the end of the year. To date the company has spent $400,980 in development and equipment of its Kamiskotia claims. No mention is made in the report of the Kamiskotia property or the prospects for resuming work there.

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Financial Notes

ALASKA JUNEAU in April, 1931, reports 360,570 tons mined and trammed, from which estimated results were as follows: receipts, $335,000, or 92.91c. per ton; operating expenditures, $194,500, or 53.94c. per ton; operating profit, $140,000, or 38.97c. per ton; and to surplus $140,500 for the month.

SHERRITT GORDON MINES, operating a copper property in Manitoba, reports total assets of $8,837,967 at the end of 1930. Up to that time, the company had spent $2,477,942 on buildings, machinery and equipment. Current assets totaled $651,501. The company has started production since the financial report was prepared.

COLOMBIA EMERALD DEVELOPMENT, operating in Colombia, reports a loss, after depreciation and general expenses, of $65,466 in 1930. Operating loss was $61,091. Emerald sales in 1930 totaled $48,135. The company puts its total assets on Dec. 31, 1930, as $5,064,954, and its deficit as $105,337.

U. S. Silver Production Down in April

Production of silver in the United States and Canada declined during April, the result of low prices for silver and base metals. Output in the United States during April amounted to 2,858,000 oz., against 3,528,000 oz. in March, and 4,627,000 oz. April last year, according to the American Bureau of Metal Statistics. Production in Canada in April totaled 1,301,000 oz., against 1,431,000 oz. in the preceding month, and 1,705,000 oz. in April, 1930.

Silver production in Peru was stepped up during April to 1,215,000 oz., but this was not regarded as significant in view of the fact that output of the precious metal in that country continues well below normal.

Mexican production statistics for March have been released and show an output of 6,511,000 oz., against 6,944,000 oz. in February, and 8,844,000 oz. in March, 1930. April statistics for Mexico are not yet available.

Australian output of 683,000 oz. during April compares with 689,000 oz. in March. Silver production in Burma for April has not been announced, but the output is expected to be about the same as in the March period—530,000 oz.

World production (about 87 per cent of the total output) during March amounted to 13,745,000 oz., against 14,137,000 oz. in February, and 16,316,000 oz. in January. World production in the first quarter of the year totaled 44,198,000 oz., against 55,476,000 oz. in the same period yast year.

Production statistics, in thousands of ounces, for February, March, and April of the current year, follow:

	Feb.	March	April
United States	3,187	3,528	2,858
Canada	1,772	1,431	1,301
Mexico	6,944	6,511	(a)
Peru	1,047	1,056	1,215
Australia	657	689	683
Burma	530	530	(a)
Totals	14,137	13,745	(b)

(a) Not yet available. (b) Incomplete.

The countries enumerated produced about 87 per cent of the world's production of silver in 1930.

■

Ventures, Ltd., Report

The annual report of Ventures, Ltd., Canadian holding company with substantial interests in various non-ferrous mining enterprises, reports shareholdings, at cost, of $5,537,249 on Dec. 31, 1930, compared with $5,284,499 on Dec. 31, 1929. The market value of listed shares at the end of 1930 was $3,264,908, and unlisted shares were given a book value of $1,199,344, indicating a considerable shrinkage from cost. The company's total assets of $6,288,606 include $53,766 in cash and $308,468 in expenditures and interests on several properties being developed under option or agreement. Inasmuch as none of the company's interests are yet in the dividend-paying stage, no earnings statement is included in the report. Among the companies in which Ventures has its largest holdings are Falconbridge Nickel, Coniaurum Mines, Opemiska Copper, Dominion Explorers, Northern Lead Zinc, and Ontario Refining.

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Financial Notes

AHUMADA LEAD, operating a silver-lead mine in Mexico, reports a net loss, after all expenses, of $43,147 in the first quarter of 1931. Sales of lead ore returned $82,308, the output amounting to 1,593,176 lb. of lead. Cash and cash assets on March 31, 1931, totaled $90,550.

HECLA MINING, operating a silver-lead mine in Idaho, reports a net profit, after all charges except depletion, of $98,608 in the first quarter of 1931, compared with $230,740 in the fourth quarter of 1930. Value of production declined from $625,293 in the fourth quarter to $422,883 in the first, as a result largely of the drop in prices of metals. Lead production was 12,607,405 lb.; zinc output, 241,209 lb., and silver output, 338,302 lb., in the first quarter of 1931. Tonnage of ore mined was 63,596.

NEW JERSEY ZINC, operating properties in New Jersey, Pennsylvania, Virginia, and Colorado, reports income, after deductions for expenses, taxes, maintenance, repairs, depreciation, depletion, and contingencies, of $660,769 in the first quarter of 1931. In addition, the company received dividends of $200,000 from subsidiaries, making surplus for the quarter $860,769. In the first quarter of 1930, income was $1,671,868 and in the last quarter of the year it was $873,367. Dividends from subsidiary companies were only $100,000.

PATIÑO MINES & ENTERPRISES, operating a tin property in Bolivia, reports a net loss, after all charges, of $163,618 in the first quarter of 1931, compared with a net profit of $150,569 in the first quarter of 1930. An operating profit of $301,735 was shown on operations during the 1931 quarter.

Nevada Deficit Smaller

After deduction of depreciation, Nevada Consolidated reports a net deficit of $56,995 in the first quarter of 1931, compared with $608,801 in the fourth quarter of 1930. The improvement is due to an operating profit of $10,188 obtained from copper production, compared with an operating loss of $630,494 in the fourth quarter of 1930. In both cases, reduction in the inventory value of copper was responsible for the failure to show substantial earnings, even with prevailing low copper prices. Actual output in the first quarter of 1931 was 32,786,338 lb. of copper, produced at a cost of 8.88c. a pound, compared with 33,166,657 lb. produced in the fourth quarter of 1930, at a cost of 8.96c. a pound. These costs do not include depreciation or taxes.

■

Tonopah Mining Income Low

Tonopah Mining, operator of a silver property in Nevada and with interests in several properties in other areas, reports a net income for 1930 of $15,981, compared with $208,777 in 1929. After deduction of expenditures for examination of outside mines, however, the 1930 addition to surplus was only $5,491, compared with $193,033 added in 1929. At the close of 1930, the surplus stood at $2,645,815. Adjusted capital-and-surplus account, if the reduction in value of investments is considered, amounts to only $662,958. The company has total book assets of $3,668,392, including $13,583 in cash and $35,174 in accounts receivable. Liabilities total $22,578. The value of 1930 production was $343,248 and the operating profit was $4,203.

■

CALLAHAN ZINC-LEAD, operating a silver-lead mine in Idaho, reports a deficit, before depreciation or depletion, of $13,701 in the first quarter of 1931. The company is on a development basis and shipped only $4,140 in ore and concentrate during the quarter.

World Production of Copper

(American Bureau of Metal Statistics)

Copper production of the world, based on fine copper content of blister, as reported by smelters, without segregation according to countries of origin, in short tons, follows:

	1930		1931			
	Nov.	Dec.	Jan.	Feb.	March	April
United States	64,816	60,022	53,429	55,229	57,922	52,085
Mexico	3,955	4,656	4,489	4,149	4,094	3,799
Canada	7,678	9,508	8,852	9,408	9,228	9,625
Chile and Peru	22,580	20,752	24,064	24,124	24,551	24,613
Japan	7,631	7,196	7,003	7,190	7,041	7,334
Australia	1,535	1,020	300	1,218	1,946	435
Germany	6,419	5,798	5,353	5,067	6,276	5,886
Other Europe (a)	12,900	13,000	12,500	11,300	12,600	12,300
Elsewhere (b)	15,700	14,300	13,400	11,000	12,800	12,600
Totals	143,214	136,252	129,390	128,685	136,458	128,677

(a) Partly estimated. Includes production of blister copper in countries other than Germany, whereof Spain, Russia, Jugoslavia, and Great Britain are the more important. (b) Chiefly Africa.

Continued Unsettlement in European Zinc Trade

INTERNATIONAL METAL SERVICE, LTD., LONDON

The general weakness which developed in copper, lead, and tin, coupled with continued free offerings, has resulted in depressing zinc prices to another new low for the movement—£10 5s. per ton. About a month ago, when the market for spot zinc stood around £11 15s., traders felt that the bottom had been reached. At current prices, the metal appears to have few friends either in or out of the market. Fluctuations in other metals are having a pronounced influence on the general situation.

Production figures for April are expected to reveal another cut in output, though much remains to be done in the matter of reducing production to a point that will permit of some depletion in the heavy stocks. World stocks at the end of April were estimated at 254,900 metric tons, against 251,000 metric tons a month previous. The difficulty in the zinc market appears to be that consumption dries up about as fast as output is trimmed. A further cause of worry, so far as Europe is concerned, is that the decline in European production has to some extent been offset by increased arrivals of zinc from Australia and Canada.

The unexpected weakness in the American zinc market has perplexed London operators. A favorite theory is that the price cutting in Prime Western zinc was brought about deliberately to bring pressure to bear on those few interests who have not been doing their fair share toward keeping output down to the desired level. But others point out that April production in the United States was actually lower than in the preceding month and the increase in stocks resulted entirely from the sharp drop in shipments to consumers.

The agreement entered into by lead producers to cut production 15 per cent should have some bearing on the zinc situation. A reduced scale of operations in lead should restrict output of zinc in both Australia and Canada.

As for the near future, nothing short of a substantial revival in the consumptive demand would greatly benefit producers of zinc. The outlook for increased business is anything but favorable. Belgium, it is true, reports a little better trade with India in galvanized sheets, but it may be that even this is only a transfer from British works by reason of the fact that the Continent has been quoting a figure well below that named by English makers. British galvanizers report very poor business and a large number of mills continue idle. In Germany, the rolling plants are operating at considerably less than 75 per cent of capacity; the brass mills in that country are not taking much more than one-third of the tonnage of raw materials absorbed at this time last year.

The one point on which operators agree is that the market has fallen to such a low point that further price recessions seem impossible.

Estimated world stocks of zinc on the last day of April, by countries, in metric tons, follow:

	Metric Tons
United States	129,900
Canada (including afloat)	31,700
Australia (including afloat)	19,700
Germany-Poland	21,800
Belgium	14,000
France	4,600
Great Britain	15,700
Other Europe	9,000
Far East	4,500
Elsewhere	4,000
Total	254,900

At the end of March stocks were estimated at 251,000 metric tons. On the last day of February the stocks stood at 253,400 metric tons.

■

Iron Ore Mined in U. S. Down 20 Per Cent

Iron ore mined in the United States in 1930 amounted to 58,408,664 gross tons, a decrease of 20 per cent compared with 1929, the U. S. Bureau of Mines reports. Shipments of iron ore in 1930 amounted to 55,201,221 gross tons, valued at $145,619,059, a decrease of 27 per cent in quantity and of 26 per cent in total value, compared with 1929. The average value per ton of iron ore at the mines in 1930 was $2.64, against $2.61 in 1929. Stocks of iron ore at mines at the end of 1930 amounted to 10,383,152 gross tons, an increase of 47 per cent.

Iron ore mined in the United States in 1929 and 1930, according to states, in gross tons, exclusive of ore containing 5 per cent or more of manganese:

State	1929	1930
Alabama	6,453,075	5,738,478
Arizona	.....	923
California	303	.....
Colorado	50,754	32,247
Georgia	59,316	52,221
Michigan	15,456,397	13,544,277
Minnesota	45,760,858	34,517,748
Missouri	168,934	132,749
New Jersey	281,327	394,639
New Mexico	171,585	173,432
New York	822,261	889,405
North Carolina	30,675	100
Pennsylvania	1,092,013	964,638
Tennessee	102,171	27,710
Utah	(a) 324,985	279,118
Virginia	.....	19,596
Washington	5,018	.....
Wisconsin	1,608,571	1,321,360
Wyoming	639,477	320,023
	73,027,720	58,408,664

(a) Revised.

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MINERALS SEPARATION, holding company with interests in metallurgical processes, reports net profit, after depreciation, of £54,658 in 1930, compared with £60,016 during 1929. At the end of the year, the company's appropriation balance showed £58,972, compared with £81,547 at the beginning. Total assets of the company on Dec. 31, 1930, were £699,896. Royalties received in 1930 totaled £77,480.

Domestic Lead Production Reduced in April

Production of refined lead from domestic ore during April totaled 35,498 tons, a decline of 6,277 tons from the output reported for the preceding month. The daily rate of production for April was 1,183 tons, a new low for the movement, and contrasts with 1,348 tons in March, 1,409 tons in February, and 1,852 tons in April, 1930.

Shipments reported during April declined moderately, the total for the period being 34,930 tons, against 36,761 tons in March.

Stocks again increased, but the gain was small compared with the first three months of the year, the total at the close of April standing at 132,993 tons, against 130,426 tons a month previous, 122,826 tons in February, and 113,145 tons in January.

Domestic lead statistics, released by the American Bureau of Metal Statistics, follow:

United States Lead Statistics

(In Short Tons)

Production	Feb.	Mar.	Apr.
From domestic ore	39,464	41,775	35,498
Secondary and foreign	4,654	3,025	2,941
Totals	44,118	44,800	38,439
Stock at beginning (a)	113,145	122,826	130,426
Total supply	157,263	167,626	168,865
Stocks at end (a)	122,826	130,426	132,993
Shipments by difference	34,437	37,200	35,872
Shipments reported	34,439	36,761	34,930

The United States lead refinery statistics account for refineries at Omaha, Selby, Perth Amboy, Carteret Collinsville, East Chicago, Herculaneum, Grasselli, Federal, Kellogg, Galena, Newark, Matawan, Indianapolis, Joplin, and Ontario.
(a) Domestic only.

The industrial classification of domestic lead shipments, for February, March, and April, according to the American Bureau of Metal Statistics, in tons, follows:

	Feb.	Mar.	Apr
Cable	10,378	9,109	9,066
Ammunition	2,762	5,517	3,722
Tin Foil	909	861	1,746
Batteries	1,504	2,182	2,534
Brass-making	118	111	263
Sundries	2,114	2,598	2,036
Jobbers	450	261	229
Unclassified (a)	16,204	16,122	15,334
Totals	34,439	36,761	34,930

(a) Of the shipments reported as unclassified, about one-third goes into white lead and about 30 per cent into red lead and litharge, as averages. Other important outlets in this classification are sheet and pipe, solder, and babbitt metal.

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Int. Nickel First Quarter

Net profit earned by International Nickel during the first quarter of 1931 was $1,659,638, compared with $4,616,144 earned in the first quarter of 1930. This figure is after depreciation, depletion, and other reserves. The company's surplus, which was $20,646,169 at the beginning of the quarter, was $19,635,531 at the end. Gross operating profit was $3,238,406, and other income was only $15,975. In 1930's first quarter, gross operating profit was $6,619,806 and other income was $297,133.

U. S. Fluorspar Output Decreased in 1930

The fluorspar industry during 1930 was adversely affected by the general decrease in operations in the industries in which this mineral is used, and as a consequence the domestic fluorspar producers' volume of business was the smallest since 1921, according to Hubert W. Davis, of the U. S. Bureau of Mines. Of interest are the substantial decrease in domestic shipments; the pronounced increase in imports from Germany and France; the increase, effective June 18, from $5 to $7.50 a short ton in the rate of duty on fluorspar containing 93 to 97 per cent of calcium fluoride; the large stocks of fluorspar at consumers' plants on Dec. 31, especially the stocks of 89,000 short tons that have been accumulated at basic open-hearth steel plants; and the accomplishment of the first river-rail shipments of fluorspar to the Pittsburgh district.

Shipments of fluorspar from mines in the United States in 1930, amounting to 95,849 short tons, consisted of 85,094 tons of gravel fluorspar, 4,281 tons of lump fluorspar, and 6,474 tons of ground fluorspar. The general average value for all grades per ton f.o.b. mine shipping points was $18.22, 84c. less than the 1929 average. The general average value of the fluorspar shipped to steel plants in 1930 from the Illinois-Kentucky district was $16.99 a ton, compared with $17.36 a ton in 1929. Fluorspar was shipped from Colorado, Illinois, Kentucky, Nevada, and New Mexico in 1930, of which only Colorado recorded an increase.

The stocks of fluorspar at mines or at shipping points on Dec. 31, 1930, consisted of 51,587 short tons of gravel fluorspar, 4,425 tons of lump fluorspar, and 464 tons of ground fluorspar, a total of 56,476 tons of "ready-to-ship" fluorspar. In addition there was in stockpiles at the close of 1930 about 53,000 tons of crude (run-of-mine) fluorspar which must be milled before it can be marketed and which is calculated to be equivalent to 26,000 tons of merchantable fluorspar. These stocks compare with 18,128 tons of "ready-to-ship" fluorspar and 55,773 tons of crude fluorspar on Dec. 31, 1929.

The imports of fluorspar into the United States in 1930 amounted to 64,903 short tons, valued at $544,656, and are the third largest ever recorded. The imports in 1930 showed an increase of 19 per cent and were equivalent to 68 per cent of the total shipments of domestic fluorspar in 1930.

The greater part of the fluorspar imported is sold for use in the steel industry. According to reports of the importers to the Bureau of Mines the selling price at tidewater, duty paid, of the imported fluorspar sold to steel manufacturers averaged $17.52 a short tons in 1930. The selling price at tidewater, duty paid, of imported ground fluorspar, which was sold to manufacturers of glass and enamel, averaged $34.93 a short ton in 1930.

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Financial Notes

ANDES COPPER, subsidiary of Anaconda Copper, reports operating revenue of $17,082,020 in 1930, operating profit of $7,259,585, and net income of $5,076,696, after miscellaneous charges, interest, and depreciation. In 1929, net income was $11,153,846 and operating profit, $14,172,314. Total assets on Dec. 31, 1930, were $97,418,655.

GREENE CANANEA COPPER, subsidiary of Anaconda Copper, reports sales of $6,223,804 in 1930 and net income of $1,276,087, before depletion, but after taxes and depreciation. In 1929, net income was $2,960,849. Total assets on Dec. 31, 1930, were $56,361,495, of which $4,780,006 was surplus, after transferring $400,000 to contingency reserves.

CHILE COPPER, subsidiary of Anaconda Copper, reports sales of $25,774,662 in 1930, on which an operating profit of $13,967,949 was realized. Sales exceeded production by more than 40,000,000 lb. of copper, being 219,485,323 lb. Net income, after taxes, interest, and depreciation, was $8,250,905. In 1929, net income was $21,821,932. Total assets on Dec. 31, 1930, were $164,849,868, of which $11,887,430 was surplus. Current assets $21,164,252.

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Yukon Gold Loss Was Large

Net loss suffered by Yukon Gold, which has interests in various tin, gold, and silver-lead properties, was $220,375 after all charges, in 1930. In 1929, a net income of $440,668 was realized. These results do not include the company's equity in undistributed earnings of any subsidiary companies. Were these included, 1930 would have shown an operating profit of $537,485 on a total production of $1,779,634, compared with $1,458,422 on a total production of $3,056,348, in 1929. Operating gain of the company's Malayan dredges in 1930 was $267,264. At the close of the year, the company had total assets of $6,801,600. Notes and interest of Pacific Tin, a subsidiary, were the chief item in the liabilities and amounted to $5,433,254.

United States Lead Statistics 1928-1930

The output of refined primary lead in the United States, from domestic ore, in 1930, amounted to 573,740 short tons, valued at $57,374,000, as shown by reports made by producers to the U. S. Bureau of Mines. The production was 15 per cent lower than in 1929 and the value was 32 per cent lower. Nearly 35 per cent of the lead produced from domestic ore was derived from Missouri; 23 per cent was derived from Idaho; and 21 per cent from Utah. The amounts produced by these states in 1929 represented 31 per cent, 22 per cent, and 23 per cent of the total, respectively. The remainder was derived from a number of states, the most important in 1930 being Oklahoma, Colorado, Kansas, Montana, and Nevada.

Refined Primary Lead Produced in the United States

(In Short Tons)

	1928	1929	1930
Domestic desilverized lead	351,734	381,487	326,801
Domestic soft lead	225,003	235,345	201,361
Domestic desilverized soft lead	49,465	55,666	45,578
Total refined (domestic)	626,202	672,498	573,740
Foreign desilverized lead	154,869	102,135	69,293
Total refined primary lead	781,071	774,633	643,033
Antimonial lead	33,058	25,669	13,711

Refined Primary Lead Available For Comsumption

Supply:	1928	1929	1930
Stocks in bonded warehouse, Jan. 1	9,464	4,139	1,328
Imports of pigs, bars, and old metal(a)	662	1,658	209
Production	781,071	774,633	643,033
	791,197	780,430	644,570
Withdrawn:			
Exports—			
Pig lead	116,269	73,251	47,971
In manufactures, with benefit of drawback	13,224	13,086	12,162
Stocks remaining in bonded warehouse, Dec. 31	4,139	1,328	(b)
	133,632	87,665	61,461
Available for consumption	657,565	692,765	583,109

Imports and Stocks of Lead in Ore and Bullion

	1928	1929	1930
Imports of lead in ore and matte	25,915	31,331	39,377
Imports of lead in bullion	128,468	83,071	38,630
Remaining in warehouse, Dec. 31:			
Lead in ore and matte	48,823	60,207	(c)
Lead in bullion	68,750	75,434	(c)
Average selling value in cents per pound	5.8	6.3	5.0

(a) Includes a small quantity, not separable, of "old, reclaimed, and scrap." (b) Figures not available. For purpose of calculating quantity available for domestic consumption stocks in warehouses are estimated to have remained unchanged from the beginning of the year. (c) Not yet available.

Sales of Copper at 8.75c., Delivered, Set All-Time Low—Lead Declines

New York, May 21, 1931.—With most of the news concerning general industrial conditions disappointing, and on continued weakness in Wall Street, the market for non-ferrous metals gave a rather poor account of itself in the last two weeks. Copper sold down to 8¾c., delivered Connecticut, a new all-time low. Lead was reduced in price to 3.75c., New York, the lowest figure named since 1915. Zinc was offered on the basis of 3.25c., St. Louis, early in the period, but steadied later on scanty offerings of concentrate. Tin prices showed little net change, notwithstanding the announcement of plans for further curtailment in output. Adoption of a resolution at the meeting of the International Chamber of Commerce calling for a conference sometime this year to study the silver situation was followed by easier prices for the metal. Platinum has been advanced, leading to the assumption that the marketing of the metal way be conducted in a more orderly way. Quicksilver showed little change.

Copper Unsettled

The price held at 9c., delivered Connecticut, until yesterday, May 20, when several lots were disposed of by custom smelters on the basis of 8¾c., the lowest price in the history of the industry. Large producers, who have not been aggressive sellers in some time, continued at 9c. Informal conferences have been held in New York by foreign and domestic copper producers to review the accomplishments of the curtailment plan that went into effect last November, and, according to reports, further curtailment in output is being considered.

Domestic demand for copper in the last two weeks has been moderate, despite the decline in the prices, sales amounting to about a thousand tons a day. Buying of copper products by the utlimate consumer has been disappointing, which accounts for the lack of demand for the metal from fabricators. Some of the brass companies have experienced a slightly better call for their products.

The export quotation has been lowered on two occasions, without stimulating foreign business to an appreciable extent. On May 13, the export price was lowered to 9.525c., c.i.f basis. Another decline was announced on May 18, establishing the export price at 9.275c., equivalent to 9c. on domestic business.

The April copper statistics were unfavorable, showing a gain in stocks of refined of 13,716 tons.

Lead at 3.75c.

The price of lead was lcwered to 3.85c., New York, on May 8, and to 3.75c. on May 11, a net decline of 25 points from the basis that obtained at the opening of the period under review. In the Middle West the net decline amounted to 20 points, reducing the differential between St. Louis and New York. The reduction in the price resulted in some good business in the week ended May 13. During the last week, however, the sales volume fell off sharply. At current prices, producers feel that production will continue to drop off.

Zinc Steadies

Failure of the Joplin market for concentrate to develop further weakness served to steady the market for the metal. Early in the period inquiry improved, attributed in part to hedging operations by some producers who found the concentrate situation rather tight. Consumers also showed more buying interest, though chiefly in futures.

Further Tin Curtailment

The feature in the market was the announcement from Holland to the effect that the International Tin Committee will recommend that output be reduced further by 20,000 long tons yearly, or a net reduction of 33 per cent from the 1929 basis. On receipt of this news, made public May 18, the London market advanced sharply. Subsequent unsettlement in other metals, and doubt as to the efficacy of the plan, caused prices to ease off again, the final quotation for Straits tin showing little change from that named two weeks ago.

Silver Declines

Despite the wide publicity given to the silver situation at the meetings of the International Chamber of Commerce, the market eased off, declining about 1c. per ounce in New York. Weakness in China exchange, coupled with sales by both China and India, brought out the lower prices.

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., delivered, Alcoa commercial and mill ingot, 99 and 98 per cent, 23.30c.; Alcoa No. 12 alloy, 22c.; metallurgical ingot, 94 per cent plus, 23.30c.; 98@99 per cent, 22.90c. London, £85, less 2 per cent, per long ton, for 98 per cent ingots and bars.

ANTIMONY—Per lb., duty paid, Chinese, spot, 6.45c.; futures, 6.35c. Cookson's "C" grade, spot, 12c. "CMC." grade, 99.9 per cent, spot, 11c.

BISMUTH—Per lb., in ton lots, $1.50. London, 6s.

CADMIUM—Per lb., 55c. London, 1s. 9½d.@1s. 10½d.

CHROMIUM—Per lb., 97@98 per cent grade, 85@90c. per lb. contained chromium, maximum 1 or 2 per cent iron.

COBALT—Per lb., delivered: Metal imported from Belgium in the form of rondelles, 97@99 per cent, spot, $2.50. Discounts on contracts. London, spot, 10s. Nominal.

INDIUM—Per gram, minimum 99 per cent, $14@$15; 98½ per cent, $90@$100 per oz.

IRIDIUM—Per oz., $105 for 98@99 per cent sponge and powder.

MAGNESIUM—Per lb., ingots (4x16 in.), 99½ per cent, 48c., in 100-lb. lots or more; 2½- or 3-lb. sticks (1⅛x27 in.), 53c., 100-lb. lots or more. London, 2s. 9d.@3s. for 99 per cent ingots or sticks.

MANGANESE—Per lb., 95@97 per cent, 42c.

MOLYBDENUM—Per lb., in 10- to 50-lb. lots, C.P. powder, $9.50; 97 per cent, $6.50. (Usually sold as calcium molybdate or ferromolybdenum, which see.)

NICKEL—Per lb. electrolytic cathodes, 35c.; shot and ingot made from remelted electro, 36c. for single lots of spot metal. London, per long ton, £170 @£175, as to quantity.

OSMIUM—Per oz., $60@$65. Nominal. London, £14.

PALLADIUM—Per oz., $19@$21. London, £3 12s. 6d.@£4.

PLATINUM—Per oz. Official price of leading interest advanced from $23 to $27.50 on May 18. Cash transactions between dealers and refiners at several dollars less. The average price of Colombian crude, basis 85 per cent platinum, for April was $19.

QUICKSILVER—Per 76-lb. flask, $101.

RADIUM—Per mg. radium content, $50 in lots of 4 grams or more, to $65 for 1 gram; smaller quantities, $70.

RHODIUM—Per oz., $50@$55. Nominal.

RUTHENIUM — Per oz., $40@$45.

SELENIUM—Per lb., $1.80@$2, depending on quantity, for black, powdered, 99.5 per cent pure. London, 7s. 8d.@7s. 9d.

SILICON—Per lb., minimum 97 per cent Si, maximum 1 per cent Fe, 15@17c.

TANTALUM—Per kilo, $91 for C.P. bar or sheet.

TELLURIUM—Per lb., $2. London, 9s. 6d.

THALLIUM—Per lb., $12.50@$15.

TITANIUM—Per lb. in 50- to 100-lb. lots, 75 per cent, $5.

TUNGSTEN—Per lb. contained tungsten, 98 per cent, powdered, $1.65. London, 2s. 3d.

Daily Prices of Metals

May	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
7	8.775	23.25	4.00	3.80	3.25
8	8.775	23.25	3.85	3.65	3.25
9	8.775	23.25	3.85	3.625	3.25
11	8.775	23.20	3.75	3.60	3.25
12	8.775	23.20	3.75	3.60	3.30@3.35
13	8.775	23.25	3.75	3.60	3.30@3.35
Av'ge	8.775	23.233	3.825	3.646	3.275
14	8.775	23.35	3.75	3.60	3.35@3.40
15	8.775	23.40	3.75	3.60	3.35
16	8.775	23.375	3.75	3.60	3.35
18	8.775	24.15	3.75	3.60	3.35
19	8.775	23.60	3.75	3.60	3.35
20	8.525	23.10@23.20	3.75	3.60	3.35
Av'ge	8.733	23.504	3.750	3.600	3.354

Average prices for calendar week ended May 9, 1931, are: Copper, 8.775c.; Straits tin, 23.221c.; New York lead, 3.950c.; St. Louis lead, 3.746c.; Zinc, 3.267c. and Silver 28.292c.

Average prices for calendar week ended May 16, 1931, are: Copper, 8.775c.; Straits tin, 23.296c.; New York lead, 3.750c.; St. Louis lead, 3.600c.; Zinc, 3.329c.; and Silver, 28.125c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices of refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. The contract price for High-Grade zinc delivered in the East and Middle West is 1c. above the St. Louis price for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

Silver, Gold, and Sterling Exchange

May	Sterling Exchange "Checks"	Silver		Gold, London	May	Sterling Exchange "Checks"	Silver		Gold, London
		New York	London				New York	London	
7	4.86 5/16	28 3/8	13 1/4	84s 11 1/2d	14	4.86	28 1/8	13 3/16	84s 11 1/4d
8	4.86 1/8	28 1/4	13 3/16	84s 9 3/4d	15	4.86 1/16	28	13 1/16	84s 11 1/4d
9	4.86 3/16	28 1/8	13 1/8	.....	16	4.86 3/16	28	13	.....
11	4.86 1/16	28	13 1/16	84s 9 3/4d	18	4.86 1/4	27 5/8	12 7/8	84s 11 1/2d
12	4.86 1/8	28 1/4	13 1/8	84s 9 3/4d	19	4.86 1/4	27 1/4	12 9/16	84s 9 3/4d
13	4.86 1/16	28 3/8	13 3/16	84s 10 1/2d	20	4.86 1/4	27 1/2	12 5/8	84s 9 3/4d

Average for week ended May 13: Silver, 28.229c.; Sterling Exchange, $4.86146.
Average for week ended May 20: Silver, 27.750c.; Sterling Exchange, $4.86167.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command five-thirty-seconds of a cent premium.

London

May	Copper Standard		Electrolytic (Bid)	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3M	Spot	3 M
7	39 15/16	40 5/8	43	104 5/8	106	11 15/16	12 3/16	10 1/2	11
8	39 7/8	40 5/8	43	104 3/4	106	11 13/16	12 3/16	10 5/8	11 1/8
11	40 3/16	40 7/8	43 1/2	104 1/2	105 3/4	11 9/16	11 15/16	10 5/8	11 1/8
12	39 1/2	40 1/2	43	104 1/4	105 5/8	11 9/16	11 7/8	10 1/2	11
13	38 15/16	39 11/16	42	104 1/2	105 7/8	11 3/8	11 11/16	10 1/4	10 3/4
14	39	39 5/8	43 1/4	105	106 1/4	11 3/8	11 3/4	10 5/16	10 13/16
15	39 3/8	40 1/16	43 1/4	105 3/8	106 5/8	11 1/2	11 13/16	10 13/16	11 1/16
18	39 3/16	39 13/16	42	109 3/8	110 5/8	11 5/8	11 15/16	10 3/4	10 7/8
19	38 7/8	39 7/16	42	106 7/8	108 1/4	11 1/2	11 13/16	10 1/2	10 13/16
20	38 11/16	39 5/16	41 3/4	105	106 3/8	11 9/16	11 13/16	10 3/8	10 3/4

Prices for lead and zinc are the official price for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

Metallic Ores

Prices in tons of 2,000 lb., or in "units" of 20 lb., unless otherwise stated.

ANTIMONY ORE—No sales reported. London, per long ton unit, 3s. 9d.@4s. for 60 per cent sulphide ore.

BERYLLIUM ORE—Per unit of BeO, minimum 11 per cent BeO, $4@$5, f.o.b. mines. Per lb. BeO contained, 30c., c.i.f. European ports. Nominal.

CHROME ORE—Per long ton, c.i.f. Atlantic ports, Indian ores, $19 for 46@48 per cent Cr_2O_3 ore, and $23.50@$24 for 50@51 per cent ore. London, 77s. 6d. for 48 per cent Rhodesian, and 80s.@92s. 6d. for Indian and New Caledonian, according to quality.

IRON ORE—Per long ton, Lower Lake ports. Lake Superior ores.

Mesabi, non-bessemer, 51½ per cent iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron, $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Eastern ores, cents per long ton unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 10c.

Foreign ores, alongside docks Atlantic ports, cargo lots, cents per long ton unit:

North African and Swedish, low-phosphorus, 9@9½c.

Spanish and North African basic, 50@60 per cent, 9c.

Swedish foundry or basic, 65@68 per cent, 9@9½c.

Newfoundland foundry, 55 per cent iron, 9c. Nominal.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, cargo lots, exclusive of duty: Brazilian, 46@48 per cent Mn, 23c.; Chilean, 47 per cent minimum, 29c.; Indian, 48@50 per cent, 25@26c.; Caucasian, 52@55 per cent, 26@27c.; South African, 52@54 per cent, 25@26c.; 50 to 52 per cent, 24@25c; 44 to 46 per cent, 23½c.

Per ton in carload lots:

Chemical grades, powdered, coarse or fine, minimum 80 per cent MnO_2, Brazilian or Cuban, $60. Javan or Caucasian, 85 per cent minimum, $60. Domestic, 70 to 72 per cent, $60, f.o.b. mines.

MOLYBDENUM ORE—Per lb. of contained MoS_2, nominally 45c., delivered Pittsburgh. London, per long ton unit, nominal at 31s. 6d.@35s. for 80@85 per cent concentrate.

TANTALUM ORE—Per lb. Ta_2O_5, 70c. for 60 per cent ore. Market nominal.

TIN ORE — No market in United States. London, returning charge on 60 per cent Bolivian, £8 15s.@£9 per long ton; on 70 per cent Nigerian, £6 17s. 6d., basis £200.

TITANIUM ORE — Per gross ton, ilmenite, 45@52 per cent TiO_2, f.o.b. Atlantic seaboard, $10@$12, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7

@$8. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c.

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Chinese wolframite, $11.25, duty paid. Bolivian scheelite, $11.50. Domestic, $12. Shipments of odd carlots do not command full prices.

VANADIUM ORE—Per lb. V_2O_5 contained. 26@28c., f.o.b. shipping point. London, 16 to 18 per cent V_2O_5, nominal at 45s.@47s. 6d. per long ton unit, c.i.f., on contract.

ZIRCON ORE — Per ton, 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots. Crude granular zircon, $70, f.o.b. Suspension Bridge, N. Y.; milled, $90.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.
Tons of 2,000 lb., unless otherwise noted.

AMBLYGONITE — Per ton, f.o.b. mines, 8@9 per cent Li_2O, $50@$60.

ASBESTOS — Per ton, f.o.b. Quebec mines, tax and bags included: Crude No. 1, $250@$300; crude No. 2, $200@$250; spinning fibers, $100@$175; magnesia and compressed sheet fibers, $100@$125; various grades shingle stock, $45@$65; various grades paper stock, $27.50@$35; cement stock, $15@$20; floats, $10@$12. Market unsettled and prices largely nominal.

Per ton c.i.f. New York: Rhodesian crude No. 1, $300; No. 2, $200. Nominal.

Per ton, c.i.f. New York: Russian crude No. 1, $225@$250; No. 2, $175@$200; No. 3, $125@$150. Nominal.

BARIUM CARBONATE (Witherite) — Per ton, 90 per cent, 200 mesh, $47; 100 mesh, $44.

BARYTES—F.o.b. mines, bags extra:

Georgia: Barytes ore, crude, $6.50 per long ton.

Missouri: Per ton, water ground and floated, bleached, $23, car lots, f.o.b. works. Crude ore, minimum 95 per cent $BaSO_4$, less than 1 per cent iron, $6.50; 1 per cent iron and 93 per cent $BaSO_4$, $6, f.o.b. mines.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent Al_2O_3, 1.5 to 2.5 per cent Fe_2O_3, $6.50@$8, f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent Al_2O_3, 5 to 8 per cent SiO_2, $6@$7.50, f.o.b. *Arkansas* mines. Pulverized and dried, 56 to 59 per cent Al_2O_3, 8 to 12 per cent SiO_2, $10@$12.25, f.o.b. *Arkansas* mines; abrasive grade, crushed and calcined, 78 to 84 per cent Al_2O_3, $14@$16, f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic ports: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.50@$6.50; one dealer reports $7 for material running 52@54 per cent alumina and 1.50 per cent silica; market fair. Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$7; French, 56 to 59 per cent Al_2O_3, 2 to 4 per cent SiO_2, $6@$8; 56 per cent Al_2O_3, 1.50 per cent SiO_2, $7; 58 per cent Al_2O_3, 3@4 per cent SiO_2, $6.50.

BENTONITE—Per ton, carload lots, f.o.b. Wyoming mines, dried and crushed, in bulk, $8; in bags, $10. F.o.b. Chicago, selected air-floated, $25.

BORAX — Per ton, carload lots, in bags, crystals, $56; granulated, $50; powdered, $57.50; f.o.b. shipping point.

CELESTITE—Per ton in carload lots, 90 per cent $SrSO_4$, finely powdered, $27.

CHINA CLAY (KAOLIN)—Per ton, f.o.b. *South Carolina* mines, crude lump, No. 1, $5; crushed air-floated, $7; pulverized, $9.

Florida, washed and crushed, No. 1, $12.50; No. 2, $12.

Delaware, No. 1, $15.

Imported English, f.o.b. American ports: lump, $17@$21 in bulk.

EMERY—Per ton, f.o.b. *New York*, domestic crude ore, $10. Other American ore, delivered to grinders, per gross ton, $15; Turkish and Naxos ore, $30@$35. F.o.b. *Pennsylvania*, in 350-lb. kegs, Turkish, Khasia, and Naxos grain emery, 6½c. per lb.; American, 3½c.

FELDSPAR — Per ton, f.o.b. *North Carolina*, potash feldspar, 200 mesh, white, $15, in bulk; soda feldspar, $18. F.o.b. *Maine*, potash feldspar, white, 200 mesh, $19, in bulk. Granular glasspar, f.o.b. *North Carolina*, $10.50 in bulk.

Virginia, No. 1, 325 mesh, $17; 200 mesh, $15@$15.50; 160 mesh, $14; No. 1 glassmakers', $11; enamelers', $12.50.

New Mexico: Crude clean No. 1 potash spar, $4.75; ground, $9.50.

FLUORSPAR — Pen ton, f.o.b. *Kentucky* and *Illinois* mines:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $15. Foundry lump, 85-5, $17. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $32.50 in bulk; $36.50 in bags or barrels. *Colorado* mines, 82-5, $12.75.

FULLER'S EARTH — Per ton, f.o.b. *Colorado*, $18, various finenesses to minus 90 mesh.

F.o.b. *Georgia* or *Florida*, 30 to 60 mesh, $17; 15 to 30, $16; 200 up, $10; 100 up, $7.

GARNET—Per ton, f.o.b. *New Hampshire* mines: concentrate, $40; washed grades, $125.

New York: Adirondack garnet concentrates, $85.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. *Colorado:*

Brilliant black, $31.65; seconds (mine run), $25.50.

Selects, $30.50, f.o.b. Utah.

GRAPHITE—Per lb., f.o.b. *New York:* Ceylon lump, 6@7½c.; carbon, lump, 3@6c.; chip, 4@6c.; dust, 2@4c.; Madagascar flake, 4@6c.

No. 1 flake, 8@16c.; fine ground, 3c. upward; amorphous, 3c. upward.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND — Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20.

GYPSUM—Per ton, f.o.b. mill, crushed rock, *Iowa*, $2.50; *Ohio* and *New York*, $3. Ground, *Ohio*, $4; *Iowa*, $6. Agricultural, $6@$7. Calcined, $6@$9.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

LEPIDOLITE—Per ton, $50@$60 for ordinary grades. Nominal.

LIMESTONE—Per ton, f.o.b. shipping points, depending on location, either lump or crushed, 25c.@$1.75.

Agricultural, $1 up to $6 per ton, as to grade and point of shipment.

MAGNESITE—Per ton, f.o.b. *California*, dead-burned, $28. Kiln run, 93 per cent MgO (artificial periclase), $70; 88 per cent MgO, $38. Caustic, 95 per cent MgO, $48; 90 per cent, $40. *Washington:* Dead-burned grain magnesite, $22.

MICA—Per ton, f.o.b. *New Mexico*, scrap, white, $21; off color, $18. Punch, white, for disks, per lb., 10c.; for washers, 8c.

Per ton, f.o.b. *New Hampshire*, roofing mica, $23; snow, $34; 40 mesh white, $40; 60 mesh, $48; 100 mesh, $60; 200 mesh, $75. Clean dry mixed bench and mine scrap, $13.

Per lb., f.o.b. *North Carolina*: Punch, 4@5c.; 1½x2 in., 25@35c.; 2x2, 45@60c.; 2x3, 85c.@$1; 3x3, $1.40@$1.60; 3x4, $1.80@$2; 3x5, $2@$2.25; 4x6, $2.75@$3; 6x8, $3.50@$3.75; 8x10, $5@$7.50. These prices apply both to No. 1 and No. 2 mica. Black-stained mica takes a discount of 10 to 25 per cent from this schedule. White North Carolina mica, 70 mesh, $60 to $80. Biotite, or black mica, $15 a ton, unground.

MINERAL BLACK—(Graphitic shale)—Per ton, 325 mesh, 75 per cent carbon. $22.50, f.o.b. *Virginia*.

MONAZITE—Per ton, minimum 6 per cent ThO_2, $60.

OCHER — Per ton, f.o.b. *Georgia* mines, $17.50 in sacks; $20 in barrels; second grade, $10. Buff clay, 98 per cent through 325 mesh, $18.

F.o.b. *Virginia,* dark yellow, 300 mesh, 60 per cent ferric oxide, in jute bags, $19.50.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4.

Tennessee, ground lime phosphate, 80 per cent through 300 mesh, 33 per cent P_2O_5, $12.80 per net ton, bags extra.

PUMICE STONE—Per lb., in barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur, c.i.f. United States ports, guaranteed 48 per cent sulphur, Spanish, 13@13¾c.

POTASH—Per ton, contracts:

	Bags	Bulk
Muriate of potash, 80@85 per cent, basis 80 per cent	$37.15	$35.55
Sulphate of potash, 90@95 per cent, basis 90 per cent	48.25	46.65
Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent	27.80	26.20
Manure salt, 30 per cent	22.15	19.15
Manure salt, 20 per cent	15.65	12.65
Kainit, 14 per cent	12.70	9.70

Prices are delivered to Atlantic ports. Discounts up to 4 per cent for early shipment. Spot prices, $1.25@$1.50 per ton higher than on contract.

[1]QUARTZ ROCK CRYSTALS—For fusing, all sizes, $250 per ton. Prisms for piezo-electrical use, $3 per lb. in small lots. Optical grades command premium.

SILICA—Per ton, water ground and floated, in bags, f.o.b. *Illinois:* 325 mesh, $16@$40 for 92 to 99½ per cent grades. Dry ground, air-floated, 325 mesh, 92@99½ per cent silica, $14@$30. Market steady. Glass sand, f.o.b. producing plant, $1.25@$5 per ton; molding sand, 50c.@$3.50; blast sand, $1.75@$6.

[1]STRONTIANITE — Per ton, lump in carload lots, minimum 90@92 per cent $SrCO_3$, $100.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines; $22 for export, Atlantic ports.

TALC — Per ton, carload lots, f.o.b. works, containers included unless otherwise specified:

New Jersey: Soapstone, ground, $10 @$12.

New York: Double air-floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75.

Vermont: 99 per cent through 200 mesh, extra white, bulk basis, $8@$8.50; 97 to 98 per cent through 200 mesh, medium white, $7@$7.50. Packing in paper bags, $1 per ton extra.

Virginia: 200 mesh, $6@$7.75; 325 mesh, $8.75@$10.50.

TRIPOLI — Per ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $15. Double ground through 110 mesh, rose and cream, $17. Air-floated through 200 mesh, rose and cream, $22.50.

Metallic Compounds

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c., delivered, all positions. London, per long ton, £19½ for Cornish white. Mexican, high grade, £17 10s.

CALCIUM MOLYBDATE OR MOLYTE—Per lb. of contained Mo, 85c.

COBALT OXIDE—Per lb., black, 70@71 per cent contained Co, $1.45@$1.75. London 8s. for black; 8s. 10d. for gray, nominal, with actual sales 30 per cent below these figures.

COPPER SULPHATE (Blue Vitriol)—Per lb., in car lots, 4¼c. for either large or small crystals.

GERMANIUM DIOXIDE—Per gram, in 200- to 300-gram lots, $3.50.

SODIUM NITRATE—Per 100 lb., crude natural, in bags ex vessel, Atlantic ports, $2.05.

SODIUM SULPHATE (Salt Cake)—Per ton, bulk, f.o.b. works, $15@$18.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6¼c.; French red seal, in bags, 9⅛c.

ZIRCONIUM DIOXIDE—Per lb. in 100- to 500-lb. lots, 87 per cent ZrO_2, commercial, 50c.

Refractories

CHROME BRICK—Per ton, f.o.b. shipping point, $45. Grecian refractory ore, 37@42 per cent, 40c. per unit.

FIRECLAY BRICK — Per M., first quality, $40, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35.

MAGNESITE — Brick, per ton, f.o.b. works, 9-in. straights, $65. Dead-burned grain, $40, f.o.b. Chester, Pa., or Baltimore.

SILICA BRICK—Per M., *Pennsylvania,* $40; *Alabama,* $50@$51; *Illinois* and *Indiana,* $49.

ZIRKITE—Per lb., powdered, 65@70 per cent ZrO_2, 3½c. Brick, straights, 80c.@$1 each.

Alloys

FERROCHROME — Per lb. of contained chromium, 4 to 6 per cent carbon, 65 to 70 per cent chromium, 11c., delivered, on contracts; spot, 11½c. Containing 2 per cent carbon, 67 to 72 per cent chromium, spot, 17½c.; maximum 0.10 per cent carbon, 26c., spot; 24½c. contracts.

FERROMANGANESE — Per gross ton furnace: domestic and foreign, 78œ82 per cent, $80@$85, contracts, depending on quantity. Spiegeleisen, 19@21 per cent, $30 for spot carloads.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, $1.

FERROPHOSPHORUS—Per gross ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50, f.o.b. *Alabama* and *Tennessee.*

FERROSILICON — Per gross ton, delivered, 50 per cent, $83.50; 75 per cent, $130; 14@16 per cent, $39, f.o.b. Niagara Falls, N. Y. Spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM — Per ton, $150, f.o.b. producer's plant, carlots.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.10@$1.15, f.o.b. works.

FERROVANADIUM—Per lb. of V contained, delivered, $3.15@$3.50.

SILICOMANGANESE — Per long ton, carload contracts, delivered, $120 for maximum 2½ per cent carbon; $130 for maximum 1 per cent carbon.

SILICON ZIRCONIUM—Per lb., 47@52 per cent Si, 35@40 per cent Zr, 18@21c.

ZIRCONIUM FERROSILICON—Per gross ton, 12@15 per cent Zr, 39@43 per cent Si, $103.50@$108.50.

Rolled Metals

COPPER — Per lb., sheets, hot-rolled, 18⅞c.; wire, f.o.b. mill, 10¾c.

LEAD SHEETS — Per lb., full rolled, 7c.; clipped, 7¼c.

MONEL METAL—Per lb., sheets, full finished, 42c.; rods, hot-rolled, 35c.

MUNTZ METAL—Per lb., rods, 15⅜c.; plates, 18¼c.

NICKEL—Per lb., sheets, full finished, 52c.; rods, hot-rolled, 45c.

NICKEL SILVER — Per lb., sheets. 10 per cent, 23⅝@24c.; 18 per cent, 27⅛@27½c. Wire and rods, 10 per cent, 27⅛c.; 15 per cent, 31⅛c.; 18 per cent, 34⅝c.

PHOSPHOR BRONZE—Per lb., sheets and rods, 5 per cent tin, 30⅛c.; wire, 5 per cent, 30⅝c.; 10 per cent, 36⅛c.

ZINC SHEETS — Per lb., 8¾c., f.o.b. works; ribbon 8¼c.; 7 per cent discount on orders for 18 tons or more.

Iron, Steel, and Coke

IRON—Per gross ton, Valley furnaces: Bessemer, $17; basic and No. 2 foundry, $17.

STEEL—Per gross ton, base prices, Pittsburgh, billets and slabs, $30; bars, plates, and structural shapes, per 100 lb., $165.

COKE—Per ton, Connellsville furnace, $2.50. Connellsville foundry, $3.50@$4.25. Byproduct coke, Ohio and Kentucky (Connellsville basis), $5.50; Buffalo and Detroit, $8@$8.50; Birmingham, foundry, $5; furnace, $3.50@$4.50.

[1]Price furnished by Foote Mineral Company, Philadelphia.